JOURNAL OF THE A·I·E·E·

MAY 1929

PUBLISHED MONTHLY BY THE
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
33 WEST 39TH ST· NEW YORK CITY

MEETINGS

of the

American Institute of Electrical Engineers

REGIONAL MEETING, South West District No. 7, Dallas, Texas, May 7-9, 1929

SUMMER CONVENTION, Swampscott, Mass., June 24-28, 1929

PACIFIC COAST CONVENTION, Santa Monica, Calif., September 3-6, 1929

REGIONAL MEETING, Great Lakes District No. 5, Chicago, Illinois, December 2-4, 1929

For future Section Meetings see A. I. E. E. Section Activities in this issue.

MEETINGS OF OTHER SOCIETIES

National Electric Light Association.

Southwestern Division, Arlington Hotel, Hot Springs, Ark., April 30-May 3 (S. J. Ballinger, San Antonio Public Service Co., San Antonio, Texas)

East Central Division, Louisville, Ky., May 7-10 (D. L. Gaskill, Greenville, Ohio)

Southeastern Division, Ashville, N. C. May 8-10 (C. M. Killian, 207 Bona Allen Building, Atlanta, Ga.)

Annual Meeting, Atlantic City, June 3-7 (A. J. Marshall, 420 Lexington Ave., New York, N. Y.)

American Electrochemical Society, Toronto, Ont., Can., May 27-29. C. G. Fink, Columbia University, New York, N. Y.

Association of Iron and Steel Electrical Engineers, Pittsburgh, Pa., June 17-21 (J. F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa.)

Canadian Electrical Association, Algonquin Hotel, St. Andrew's by the Sea, N. B., June 19-21 (H. M. Lyster, Power Bldg., Montreal, Can.)

Society for the Promotion of Engineering Education, Ohio State University, Columbus, June 12-22 (F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.)

JOURNAL

OF THE

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33 West 39th Street, New York

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Vol. XLVIII — MAY 1929 — Number 5

TABLE OF CONTENTS

Papers, Discussions, Reports, Etc.

Institute and Related Activities

A REQUEST FOR CHANGE OF ADDRESS must be received at Institute headquarters at least ten days before the date of issue with which it is to take effect. Duplicate copies cannot be sent without charge to replace those issues undelivered through failure to send such advance notice. With your new address, be sure to mention the old one, indicating also any changes in business connections.

American Institute of Electrical Engineers

—*Some Activities and Services Open to Members*—

Conventions.—The Institute holds three national conventions each year; the Winter Convention in January, the Summer Convention in June, and the Pacific Coast Convention usually in September.

The Winter Conventions are usually the outstanding technical meetings of each year and are held in the eastern section of the country, generally in New York City. The programs consist chiefly of technical sessions which occupy practically all the available time of a five-day meeting, except one day, which is set aside for inspection trips to engineering works of interest in the neighborhood of the convention city. The only social function, aside from the entertainment provided for ladies in attendance, is a dinner-dance held on one evening during the convention. The Winter Conventions have been described as the "working conventions" of the Institute because the social and entertainment features are almost entirely subordinated to the consideration of technical papers.

Attendance at Conventions.—Taking part in the Institute conventions is one of the most useful and helpful activities which membership in the Institute affords. The advantages offered lie in two distinct channels, technical information and personal contacts. The papers presented are largely upon current problems and new developments, and the educational advantages of hearing and taking part in the discussion of these subjects in an open forum cannot but broaden the vision and augment the general knowledge of those who participate. Equally advantageous is the opportunity which conventions afford to extend professional acquaintances and to gain the inspiration which grows out of intimate contact with the leaders in electrical engineering. These conventions draw an attendance of 1000 to 2000 people and constitute milestones in the development of the electrical art.

Presentation of Papers.—An important activity of the Institute is the preparation and presentation of papers before meetings of the Institute. Opportunity is offered for any member to present a paper of general interest to engineers at an Institute meeting, or of having shorter contributions published in the Journal without verbal presentation. In preparing a paper for presentation at a meeting, the first step should be to notify the Meetings and Papers Committee about it so that it may be tentatively scheduled. Programs for the meetings are formulated several months in advance, and unless it is known well in advance that a paper is forthcoming, it may be subject to many months delay before it can be assigned to a definite meeting program. Immediately upon notification, the author will receive a pamphlet entitled "Suggestions to Authors" which gives in brief form, instructions in regard to Institute requirements in the preparation of manuscripts and illustrations. This pamphlet contains many helpful suggestions and its use may avoid much loss of time in making changes to meet Institute requirements.

Manuscripts should be in triplicate and should be submitted at least three months in advance of the date of the meeting for which they are intended. These manuscripts are submitted first to the members of the technical committee covering the subject of the paper, and if approved will next go to the Meetings and Papers Committee for final disposal. After final acceptance, the paper goes to the Editorial department for printing which requires usually from two to three weeks. Advance copies are desired about ten days prior to the meeting in order to distribute the paper to members desiring to discuss it. Considering the routine through which all papers must pass, the advantage of prompt notification and early submission of manuscripts will be apparent.

JOURNAL OF THE A. I. E. E.

DEVOTED TO THE ADVANCEMENT OF THE THEORY AND PRACTISE OF ELECTRICAL ENGINEERING AND THE ALLIED ARTS AND SCIENCES

The Institute is not responsible for the statements and opinions given in the papers and discussions published herein. These are the views of individuals to whom they are credited and are not binding on the membership as a whole.

Vol. XLVIII | MAY, 1929 | Number 5

*To the Members of our Student Branches:**

IN a few weeks a large number of you will bid farewell to your Halls of Learning and will begin your active engineering careers. You have spent many years preparing yourselves to be fit and useful citizens. Appreciating that a successful life is one of service you have chosen engineering as the channel through which to serve.

What will be the quality of your service and what satisfaction are you going to get from it? It is a trite saying and true that one gets out of life pretty much what one puts into it.

Your education has aimed to prepare you to add to the richness of life,—your life and your fellows'. If you have become technicians only you are in danger of continuing along narrow lines with a limited outlook. If, on the other hand, you have broadened your viewpoint and your contacts with the humanities without sacrificing the acquirement of the necessary technical foundation, if you have familiarized yourselves with the ideals that have inspired mankind through the ages, if you have developed an appreciation of the beautiful and take an interest in history and art as well as in engineering and economics, then you are indeed well started on the road leading to a balanced and well rounded life. We do not live by bread alone, and a life wrapt up in materialism misses the rich enjoyment that comes from the finer, the cultural and the spiritual contacts.

In selecting the field for your activity after graduation choose that which most appeals to your enthusiasm. There is nothing more sustaining to health and happiness than enthusiasm in work. Study the purpose of your work and learn its particular relation to the rest of the business that you are in, but remember also the importance of knowing how to spend your time when off the job, for your growth still continues after graduation.

You will find your professional interest broadened and increased if you take an active part in an Institute Section. The Institute is organized to help in your development but you must take the initiative. Don't wait for the membership or the attendance committee to find you.

You are now a citizen, one with a special obligation to your fellows due to your education and training. You can pay that obligation only by taking an active interest in the affairs of your community and of your country, and particularly in those affairs where your engineering training gives you a clearer understanding than the general public would naturally have. Here your ability as a convincing speaker, acquired with your studies, will have play and will help you win standing with your fellows.

You are a member of no mean profession. By being a worthy member, broad minded, tolerant and true and using your talents as is expected of an engineer-citizen you will reflect credit on yourself and on your profession and you will have that deep satisfaction which comes from the knowledge that you are helping to move civilization onward and upward.

R. F. Schuchardt

President.

* This month's message is in response to a recommendation made recently by the Student Activities Committee of the Fourth District.

Some Leaders of the A. I. E. E.

Bernard Arthur Behrend was born in Villeneuve, Switzerland, May 9, 1875. He was educated by tutor and studied at the Polytechnic Institute and the University of Berlin. In 1895 he was assistant to the late Gisbert Kapp and in 1896 he became Assistant Chief Engineer to the Oerlikon Company in Switzerland. Thence he came to the United States in 1898, subsequently becoming non-resident lecturer at the University of Wisconsin. In 1899 he became connected with the Bullock Electric Mfg. Co. of Cincinnati, Ohio, as Chief Engineer of its alternating-current work and later, as Chief Engineer of all its plants in the United States and Canada. In 1904 the Bullock Company became allied with the Allis-Chalmers Company and Mr. Behrend became Chief Engineer of the electrical departments of this country, establishing the department in Milwaukee for the manufacture of large units. At the end of 1908 the receivers of the Westinghouse Company engaged Mr. Behrend and members of his staff to take charge of the power engineering department at East Pittsburgh. Remaining connected with these interests for eighteen years, he devoted himself to general consulting work in Boston.

In 1896 Mr. Behrend published his first paper on the circle diagram of the induction motor, which has since been generally adopted in the form in which he first gave it thirty-three years ago. It formed the subject of his Wisconsin lectures in 1899 which were published later in book form under the title "The Induction Motor,"—a short treatise on its theory and design. Translations of this book appeared in French, German, and, in sections, in Japanese.

In 1897 he developed the theory of the regulation of alternators under inductive loads and urged its adoption for purposes of standardization. This is now generally adopted as first proposed by him, though sometimes known under the name of the "Potier" method; a paper before the Institute described the method, with recommendations for standardization. Among other contributions are his Institute papers on the mechanical forces in dynamos caused by magnetic attraction, elementary theory of surges on long lines, the testing of alternators by splitting the field circuit, the proposal, in 1907, to wind electric generators for 22,000 volts or more, and the demonstration of the feasibility of this voltage on 100-kw. generators. In 1902 Mr. Behrend introduced the radial-slot cylindrical turbo rotor type with chrome nickel end rings which is now generally used by all manufacturers of turbo generators. The Bullock Company, jointly with Hoovens, Owen & Rentschler, exhibited a 1000-kw. unit of this type at the World's Fair in St. Louis, in 1904. The unit received a grand prize and Mr. Behrend a gold medal. The largest power unit of the exposition, a 3500-kw. generator driven by an Allis Chalmers engine, was also designed by Mr. Behrend and it secured for itself the name of the "Old Reliable," as it was always functioning when other units were out of commission.

Between 1900 and 1908 Mr. Behrend designed the electric generating units for the Kern River Power Company, the Pacific Electric Company, the Denver Gas & Electric Company, a large group of units for Niagara Falls, the receiving plant of frequency changing units at Montreal, linking the Shawinigan Water & Power Company with the power plants at Montreal, the steam turbine units of the Brooklyn Edison Company and Brooklyn Rapid Transit Company, at that time the largest and fastest of their type. The large gas engine driven units of the Carnegie Steel Company, of the Illinois Steel Company, and of the Indiana Stee Company at Gary, Indiana, were designed by him, representing of the pioneer installations of the world. All necessary calculations for the conditions of parallel operation were carried out by Mr. Behrend, leading to the adoption of very light flywheels of about one-half the moment of inertia demanded by the engine builders.

In 1909 Mr. Behrend introduced the radial slot rotor into the Westinghouse Company and he developed the plate rotor construction now adopted by the Westinghouse Company for its largest sizes of turbo rotors. It was a revolutionary type devised for the purpose of overcoming the defects of large forgings and castings.

Devoted to engineering education in 1901 he started the first engineering training classes at Cincinnati, under Mr. A. G. Wessling. Among his well-known associates have been A. B. Field, who did his work on eddy currents in large slot-wound conductors in Mr. Behrend's office; C. J. Fechheimer, now research engineer for the Westinghouse Company; Messrs R. B. Williamson, Bradley T. McCormick, C. W. Johnson, Alexander Miller Gray were all trained in his office; Mr. F. D. Newbury was his assistant in Pittsburgh.

Mr. Behrend has taken out over eighty patents, mostly assigned to the Allis-Chalmers and Westinghouse Companies. He served on many committees, among them the Standards Committee, the U. S. National Committee, of the International Electrotechnical Commission, the Library Board, the Edison Medal Committee, and others. He was Chairman of the Committee on Professional Conduct, and the Electrical Machinery Committee. He was the first Chairman of the first Institute Section at Cincinnati, and he served five years as a Manager and Vice-President of the Institute.

In 1912 he received the John Scott Medal for improvements on high-speed electric generators. He is a member of the A. S. M. E., the A. S. C. E., and the Franklin Institute; a Fellow of the American Physical Society, the American Association for the Advancement of Science, the American Academy of Arts and Sciences, and of the A. I. E. E.

Abridgment of

Operating Experience with the Low-Voltage A-C. Network in Cincinnati

BY F. E. PINCKARD[1]

Associate, A. I. E. E.

Synopsis.—This paper describes briefly the operating experience arising from the installation of a four-wire 120/208-volt network with combined light and power mains. The most interesting problems of operation are outlined with their subsequent solutions. Fifteen months' network operation indicates that with care in layout and selection of equipment, important operating problems would be negligible.

* * * * *

Introduction

When the a-c. network system was inaugurated in Cincinnati, very few published data were available concerning actual network operating experience. Naturally, numerous problems arose concerned with the design and operation of equipment and the application of the network system to various types of customers' equipment. The problems have been treated with varying degrees of success, and this paper will attempt to present the most interesting of them.

The a-c. network here was designed to ultimately replace the existing three-wire d-c. Edison network in the one sq. mi. of congested business district having a peak demand of 24,000 kw. The ultimate layout provides for eight 13,200-volt feeders of 40,000-kv-a. total capacity with transformer vaults at each intersection and between intersections, as the load warrants. Ten per cent impedance transformer banks of 300- and 450-kv-a. capacity with 400,000 cir. mil secondary combined light and power mains connected four-wire, 208 volts, star, were made standard. A line diagram of the system is shown in Fig. 1.

Network Equipment Problems

With the slight amount of load served by the first network installations, it was natural that the first problems to be encountered were concerned with the network equipment, and particularly with the automatic network circuit breakers. It should be mentioned here that a number of the problems encountered were the results of the extremely small load on the network at the start, and are of importance not so much from the standpoint of service as from the experience gained in the operation of the equipment under this condition.

The first problem arose in one new building where unit multi-voltage type elevators were installed, and where the initial lighting load was small. It was found that network breakers would open due to power reversals. Investigation revealed that elevators using regenerative breaking may feed energy back into the network to the extent of one-third or more of their normal demand. This feedback was sufficient to trip the network breakers which were set for a reversal of approximately five amperes, which is less than the energizing current of the transformer. To correct this condition, heavier magnets were installed on the relays with some success, and later, the current required for tripping was increased to a value just below the magnetizing current of the transformer, thus eliminating most of the trouble occurring during the light-load periods. The gradual increase in the light load served to absorb these reversals.

After solution of the above problem, breaker pumping

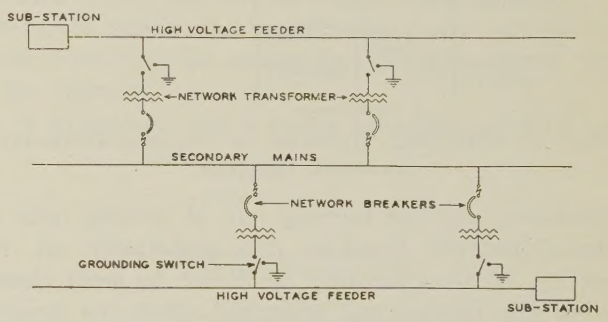

Fig. 1—Single Line Diagram Showing Schematic Arrangement of Low-Voltage Network

was still noted. Investigation revealed that this pumping was due to a slight phase-angle difference between the two primary feeders, which originated at different substations. The single-phase breaker relay was designed to prevent this, but on checking this relay, it was found that the potential elements were reversed. Correction of connections eliminated pumping, but due to light loads, a number of the breakers on one feeder now remained open a considerable part of the time.

When loads of even moderate size were thrown on and off near one of these breakers, severe voltage variations due to the breaker opening and closing occurred. Under these conditions, satisfactory service was impossible; so one feeder was extended to a generating station, thereby reducing the phase-angle difference from two deg. to zero thus eliminating the trouble.

1. Electric Distribution Dept., The Union Gas and Electric Co., Cincinnati, Ohio.

Presented at the Regional Meeting of the Middle Eastern District of the A. I. E. E., Cincinnati, Ohio, March 20-22, 1929. Complete copies upon request.

The large number of breaker operations caused by the power reversals, phase-angle difference and load variations directed attention to the mechanical features of the breakers themselves. Failures of breaker trips and closing solenoids were frequent, and complete inspection as often as twice weekly was necessary to insure satisfactory operation. These failures brought breaker design and construction under serious consideration, particularly with respect to life and accessibility for repair.

The failures could be divided into two classes,—failure to trip due to faulty trip mechanism or poor

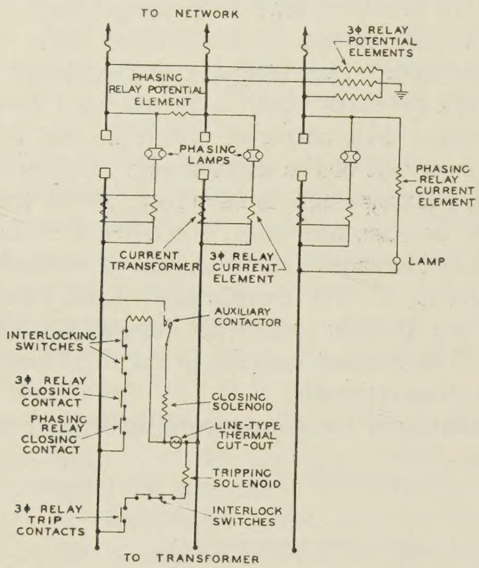

FIG. 4—SIMPLIFIED DIAGRAM OF SOLENOID-OPERATED NETWORK BREAKER

adjustment, and the burning out of closing coils on solenoid-operated breakers due principally to the tendency of the auxiliary contactor to weld closed, leaving the closing coil energized after the breaker had closed.

The failure to trip was solved by replacing the old trip mechanism with a new type developed by the manufacturers. The protection of the closing coils was obtained by the use of a link type thermal cut-out arranged so as to protect both the main and auxiliary solenoids as shown in Fig. 4.

Since it was deemed undersirable to jeopardize the tripping function in any way, the idea of fuse protection in the trip circuit was abandoned. The inaccessibility of the submersible breaker for repair or maintenance resulted in the division of the supporting panel into three parts, the upper and lower parts supporting the breaker terminals, and the middle part supporting the operating mechanism. This middle part was designed to permit easy removal from the case for repair.

To check the operation of the trip mechanism, each primary feeder was opened daily during light-load periods. This probably served as well to keep the mechanism in a flexible condition.

Improved operation was obtained by requiring more rigid laboratory tests before placing the breakers in service. These tests are made to reveal any mechanical or electrical defects due to manufacture or damage in shipment, and also to provide inspection and adjustment of all electrical and mechanical parts, including closing and tripping features, contact pressure, and three-phase and single-phase relay operations.

Routine tests are maintained after the breakers are put into service. These tests include checks on the tripping solenoid and closing mechanism, air-pressure tests to assure tightness of the submersible cases, and voltage-drop tests across breaker contacts to indicate faulty contacts or breaker overload. No attempt is made to test the relays in service but each relay is returned to the laboratory at least every three months for a comprehensive test.

One function of the network which is of primary interest is its ability to burn clear any secondary faults. Since the secondary mains installed were all new cable, secondary faults were cleared without noticeable effect on the system. One of these faults occurred in a splice,—a very severe test of the ability to clear, but the action was entirely successful even though the time of clearing was prolonged.

Only one high-voltage fault occurred,—the failure of a transformer bushing. The oil circuit breaker opened on current to ground and all breakers cleared successfully. The difficulties experienced in locating this fault are of interest.

The usual method of locating high-voltage cable faults has been to break down the insulation resistance at the fault, circulate about 30 amperes, d-c., through the conductor and back through the lead sheath; then to locate the fault by means of a multi-voltmeter, used

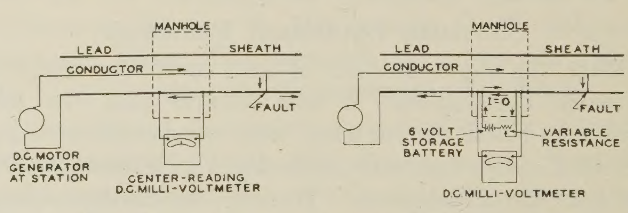

FIG. 5—(a) USUAL METHOD OF LOCATION OF HIGH-VOLTAGE CABLE FAULTS
(b) METHOD OF LOCATION OF HIGH-VOLTAGE NETWORK FEEDER FAULTS

to indicate the direction of flow in the sheath. Due, however, to the large number of return paths for the sheath current, (since the lead sheath is grounded to the transformer case and the transformer case is in turn grounded to the neutral), an attempt to locate the fault by this method proved unsuccessful and conflicting and misleading results were obtained.

A second method which is quite satisfactory for locating primary faults has since been devised. Direct current is circulated through the fault as before, and the sheath current is then neutralized in the various manholes by current supplied from a storage battery. The

direction of the fault is shown by the effect of the fault current in the conductor on a compass needle.

Diagrams of these two methods are shown in Fig. 5.

Regulation

Regulators were not installed on the primary feeders until some time after the network was in service. Two single-phase regulators, connected open delta and mechanically interconnected, were installed on each feeder. A slight difference in secondary phase voltage, noticed soon after they were in service, was remedied by

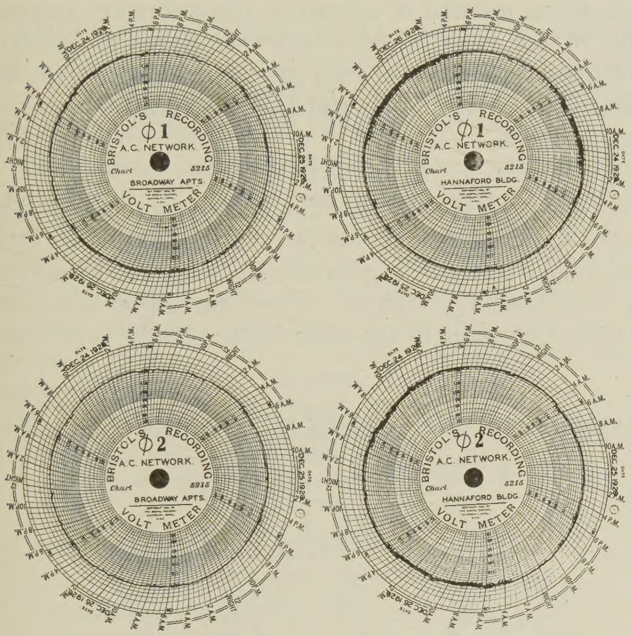

Fig. 6—Voltage Charts from Representative Network Services

adjustment of the mechanical connection between the two regulators of one feeder. Because of the possibility of causing pumping, and also because of the various types of load connected, no attempt was made to regulate to any one point on the secondary, but rather to regulate to imaginary points approximately half-way through the secondary of each transformer, using the same compensator setting on each feeder.

When the regulators were put in service, it was found that the kv-a. load of one was at times double that of the other, whereas the division had taken place even before using the regulators. No appreciable phase-angle difference existed, and changes in compensation failed to improve matters. It was finally discovered that one set of regulators was not operating properly due to an improper internal connection. After this fault was corrected, compensation was determined by trial, and to date, the operation has been satisfactory.

It may be of interest to know that there is no mechanical nor electrical connection whatsoever between the two sets of regulators, one set operating on a feeder from a generating station, and the other on a feeder from a substation fed from this generating station and supplying both d-c. and a-c. loads.

Four general types of load are supplied by the network: manufacturing, hotel, office building, and theater. The voltage charts shown in Fig. 6 are typical charts and indicate that regulation on the above basis gives uniform voltage throughout the system despite the various types of load served.

No network disturbances have occurred since the regulators have been in operation; hence no data are available as to their behavior under such conditions.

To prevent the starting currents drawn by large motors from lowering the lighting circuit voltage excessively, reactors were placed in the secondary bus as shown in Fig. 7. These reactors, of course, cannot be used for regulation purposes with a single transformer. Where a single transformer supplied both light and power, disturbance was prevented by reconnection of the motor starters. This required a longer starting time for the motors, but there were no complaints on this account.

Regulations are contemplated requiring the use of increment starters on motors connected to the network where the motor is large enough to cause lighting flicker. The use of this type of starter on a 200-hp. motor connected to compressors produces no noticeable change in the lighting voltage.

Operating Problems on Consumer's Equipment

Since 120 volts for lighting has been standard in Cincinnati for a number of years, especially since it offers more nearly the rated three-phase voltage for motors, there was no reason for deviating from this for the network.

It is recognized that a motor operating with 75 per

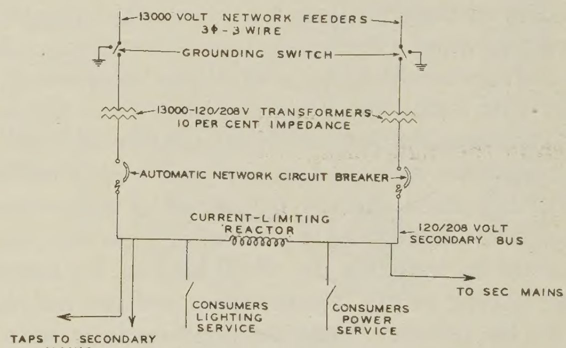

Fig. 7—Line Diagram of Double Transformer Vault Installation

cent or less of rated load will give just as satisfactory service when operated on 208 volts as when operated on 220 volts, and as had been expected, the greater part of the motor installations to be changed to the network service was found to fall in this class.

Auto-transformers have been installed for heating units rated at 220-240 volts; also in a few cases where contracts made with customers prior to the installation of the network contained clauses requiring 240 volts, three-phase service for power. It is no longer the practise, however, to install them for new loads.

Design and Construction Details

Figs. 8 and 9 show the construction details of sidewalk vaults which are typical of a majority of the

installations here. In the case of the double vault, the breaker compartment is located within the building wall, while the single vault is located entirely within the sidewalk. The transformers are of the type ordinarily used for low-voltage networks with grounding switch on the high side having line open, ground, and

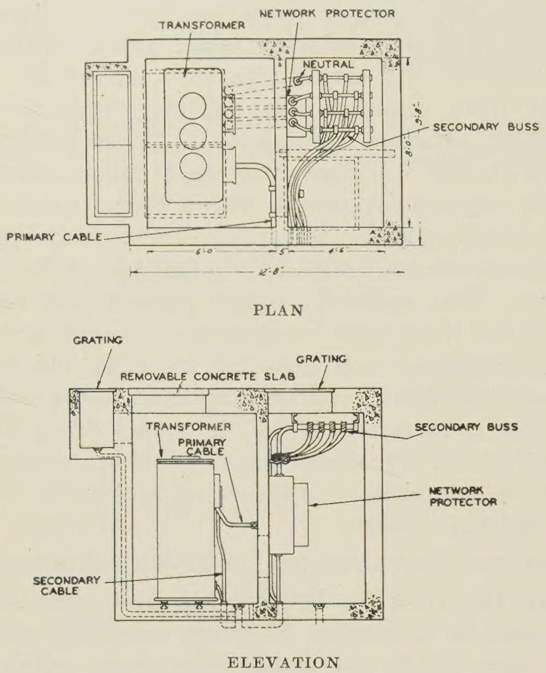

FIG. 8—STANDARD SIDEWALK VAULT FOR INSTALLATION OF ONE THREE-PHASE TRANSFORMER

closed positions. A holding coil energized by the secondary of the transformer prevents the operation of the switch when the transformer is energized. Both open and submersible type network breakers are used, the former when installed in buildings, the latter in sidewalks. In all cases transformers are of the submersible type.

Considerable reduction in size and weight of transformers has been effected by installing the grounding switch in the high-voltage pothead. This also permits such work as changing the oil to be done by throwing the grounding switch to the open position instead of opening the primary feeder as was necessary with the old type transformers.

The simplicity of installation makes the use of three-phase transformers more desirable than three single-phase transformers.

Experiences indicate that sidewalk vaults are preferable to those in buildings from the standpoints of installation, removal, and operation of equipment.

The necessity of phasing out from substations is eliminated by marking each phase in every splice. This saves much time in cutting in new banks and replacing faulty lengths of cable.

EQUIPMENT CHARACTERISTICS

The shunt-trip type of network breaker was selected in preferance to the holding coil type because of the possibility that voltage disturbances of a general nature might cause undue outages, since the holding coils will not stay in below 35 per cent normal voltage. Later experience proved the wisdom of this selection when several undesirable outages were prevented by the use of the shunt-trip type.

In selecting the amount of transformer impedance necessary, it was felt that it should be as high as was possible commensurate with satisfactory regulation. The use of high impedance reduces the size of the secondary mains allowable due to limiting the fault current, but this difficulty can be overcome by installing more than one set of smaller mains. This is usually the most economical method of extending the secondary system. The 10 per cent impedance transformers as used in Cincinnati have proved very satisfactory, both from the standpoint of regulation and load distribution between transformers.

CONCLUSION

As has been stated, the difficulties encountered were not of major importance and investigation as to their causes showed that the remedies to be applied were after all comparatively simple. They did serve, however, to bring out many of the main features to be considered

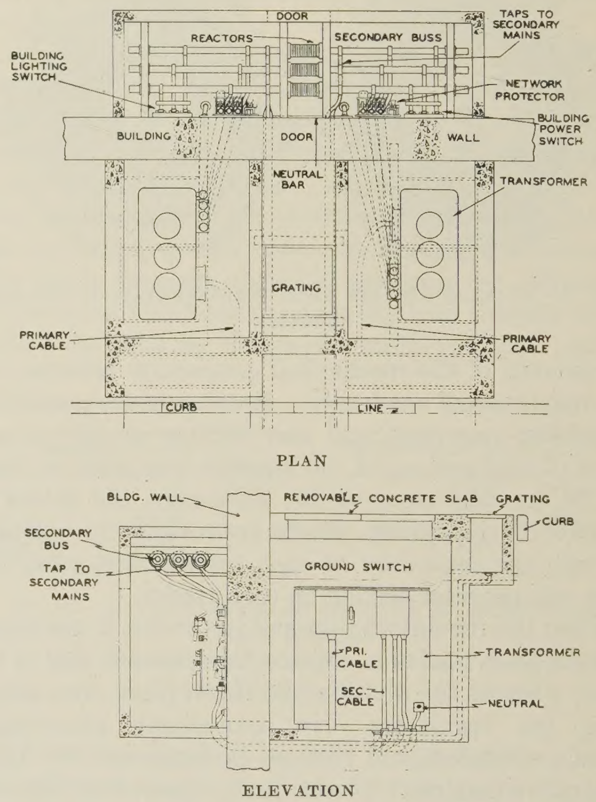

FIG. 9—STANDARD SIDEWALK VAULT FOR INSTALLATION OF TWO THREE-PHASE TRANSFORMERS

in the layout of the system and in the selection and maintenance of the equipment.

Here, it has been the aim to furnish a-c. service to the downtown district comparable in reliability with that of the Edison System. Since there have been no interruptions in service other than local ones during the fifteen months that the low-voltage network has been in operation, it is felt that this has been accomplished.

Abridgment of

Electrical Equipment of Bar Plate and Hot Strip Mills

BY J. B. INK[1]

Member, A. I. E. E.

***Synopsis.**—The paper describes the electrical features of a continuous bar plate and hot strip mill recently placed in service at Middletown, Ohio, including information regarding the general layout of the plant, the electrical circuits, rolling mills, the various motor drives, control arrangements, the motor-generator sets for supplying d-c. motors, and the safety devices. It also gives test data on the power consumption.*

* * * * *

THE purpose of this paper is to describe the electrical features of the continuous bar plate and hot strip mill recently placed in service by The American Rolling Mill Company at Middletown, Ohio.

The new mill produces ingot iron and various grades of steel strip in gages down to 0.093 in., and widths up to 48 in. Also plates ¼-in. thick and 60-in. wide in 75-ft. lengths. These products are rolled from 6-in. thick slabs, 39-in. long and of the width required in the finished product. For ease in handling and storing, the strip steel is coiled on leaving the last stand of the hot strip mill.

The mill consists of 11 stands. The first seven constitute the "bar mill" and normally reduce the sheet to about 3/8-in. thickness. The last four stands are the "hot strip mill." Between stands No. 7 and No. 8 is a runout table, transfer and bar piler for taking off sheet bar or other heavy gage product.

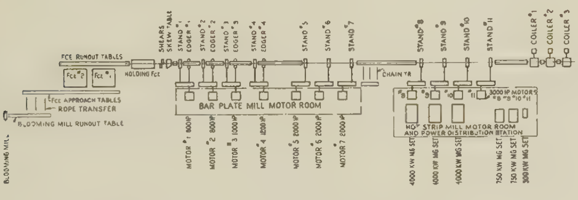

FIG. 1—GENERAL ARRANGEMENT OF BAR PLATE AND HOT STRIP MILLS

The independent stands No. 1 to No. 4 are each driven by a wound secondary induction motor and are equipped with fly-wheels. The motor horsepower varies from one quarter to one half the total rolling hp., the balance of the rolling energy being taken from the fly-wheel. The output of the motor is limited by automatic liquid slip regulators which introduce resistance in motor secondary as the motor primary current increases and so permits the fly-wheel to give up stored energy.

1. Dwight P. Robinson & Company, Inc., Middletown, Ohio.

Presented at the Regional Meeting of the Middle Eastern District of the A. I. E. E., Cincinnati, Ohio, March 20-22, 1929. Complete copies upon request.

The characteristics of the first four stands are as follows:

Motor	Hp.	Speed synch.	Fly-wheel hp. sec.	Gear ratio	Mill rev. per min.	Roll dia. inches	Roll ft./min.
1	800	514	30,000	35:1	14.42	32	121
2	800	514	30,000	35:1	14.42	32	121
3	1000	600	40,000	29:1	20.18	32	169
4	1200	720	40,000	29:1	24.3	32	203.5

Motor primary is connected to main bus by Westinghouse type OE6 oil circuit breaker. For plugging there is provided a Westinghouse Type B2 breaker which connects the motor to reverse bus. The reverse bus is connected to main bus by an OE6 breaker. The forward breaker and reverse bus breaker are automatic on overload and under-voltage. Thus one automatic breaker gives under-voltage and overload reverse protection to the four motors.

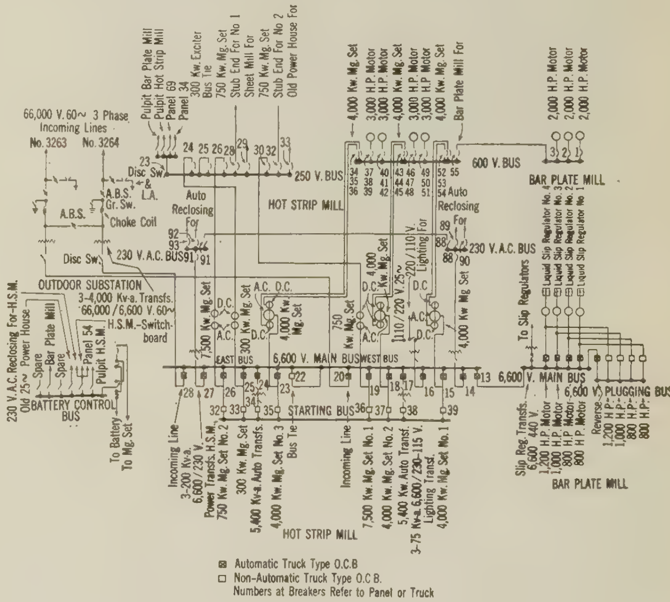

FIG. 2—DIAGRAM OF ELECTRICAL CIRCUITS IN ROLLING MILL

Oil circuit breakers are truck type having all hot parts enclosed. Forward and reverse breakers are interlocked electrically and mechanically to prevent simultaneous closing.

The inter-dependent stands No. 5 to No. 11 inclusive are driven by 600-volt d-c. adjustable speed motors. Due to the necessity for close speed regulation and the fact that the piece is in the stand a considerable length of time fly-wheels are impractical on these stands.

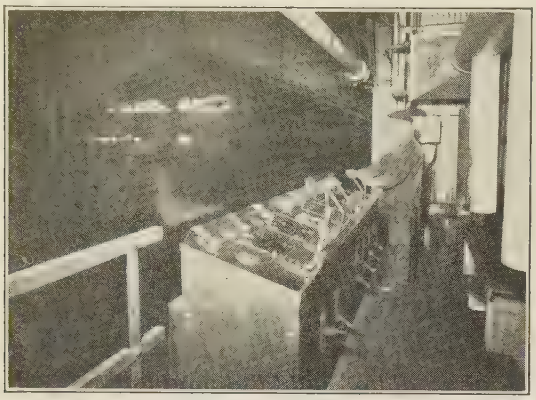

Fig. 3—Control Pulpit, Hot Strip Mill

This pulpit controls four 3000-hp. adjustable speed d-c. motors and approach and run-out tables for this mill.

The motors, therefore, must provide maximum rolling torque.

Characteristics of stands No. 5 to No. 11 are as follows:

All 4-high 56-in., working rolls 18-in. diameter, backing up rolls 36-in. diameter, roller bearings.

Motor	Hp.	Speed	Gear ratio	Mill r. p. m.	Roll ft./min.
5	2000	300–500	8.1:1	37.1/ 61.70	174.7–291.0
6	2000	300–500	6.00:1	50 / 83.3	235.4–392.0
7	2000	300–500	5.32:1	56.4/ 94.1	266.0–443.0
8	3000	180–360	3.02:1	59.6/119.2	280.5–561.0
9	3000	180–360	2.26:1	79.7/159.4	375 –750.0
10	3000	180–360	1.87:1	96.3/192.6	454 –908.0
11	3000	180–360	1.72:1	104.8/209.6	494 –988.0

The seven d-c. 600-volt motors are heavy duty type with low pedestal bearings and fabricated structural steel bases. The 3000-hp. motors being of very low speed require forced air ventilation. Motors are equipped with bearing thermostatic relays, overspeed devices, and heaters to prevent sweating during shutdown. To each shaft is geared a speed-indicating magneto. These motors are constant horsepower, speed adjustable by field control. Motors are compounded by use of series exciters. The series exciters consist of generators driven by 5-hp. induction motor. The generator field is excited by three quarter turn of the main motor armature circuit, so that the voltage generated is proportional to the input to the main motor. The generator circuit supplies a series field winding similar to the shunt winding on the main motors. Shunt-field excitation is at 250 volts.

Compounding is adjusted to different motor speeds by a rheostat in the series exciter circuit. This rheostat being on the same shaft as the main shunt-field rheostat is automatically adjusted with main shunt field.

The d-c. motors are controlled entirely from the operator's pulpit, except that emergency stop-control switches are provided in motor rooms. They are started from a 600-volt d-c. bus through series resistance and contactors using current limit accelerating relays. Dynamic breaking is used in stopping mills.

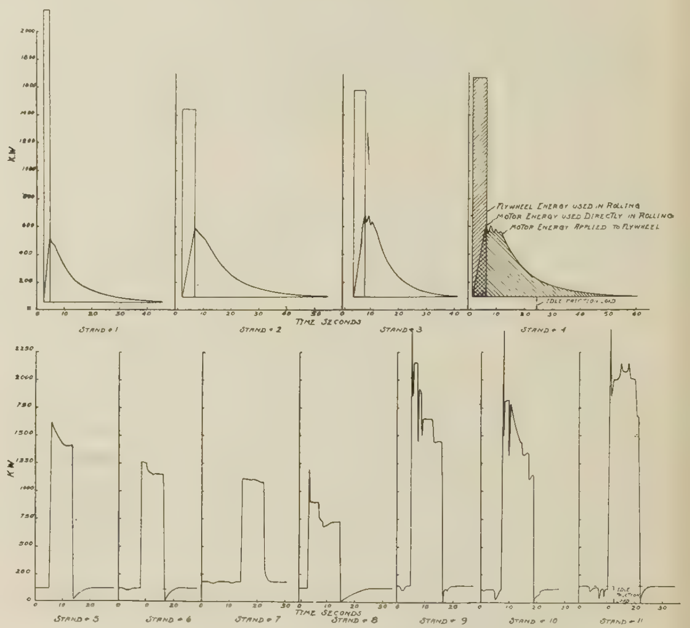

Fig. 4—Input to Mill Motors

Motors are protected from overload, low-voltage, field failure, and over speed. Each motor control panel is connected to the main bus through disconnects so that panels may be isolated for repair without killing the main bus.

With a few exceptions the mill auxiliaries are motor

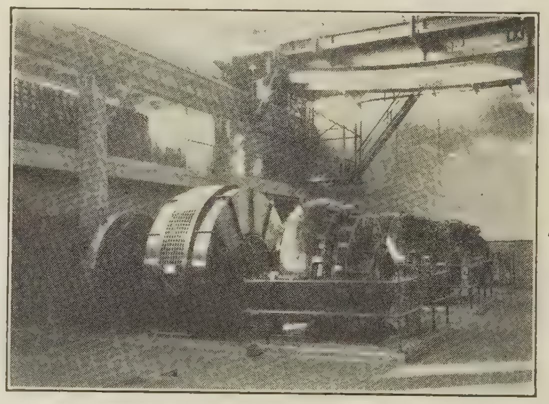

Fig. 5—4000-Kw. 600-Volt D-C. 6600-Volt A-C. Motor Generators

These machines supply d-c. power for the d-c. mill motors

operated, 220-volt squirrel-cage induction type motors with magnetic cross-line starters being used for all constant speed continuous duty applications, such as fans, pumps, and chain tables between mills. These motors are in sizes from 2 to 75 hp. They are standard sleeve bearing motors with drip proof covers. The

cross-line starters provide low-voltage protection and have thermal overload relays.

For intermittent duty on loads having high starting torque and requiring quick acceleration, 250-volt d-c. mill type series or compound motors are used. This includes all cranes, transfer tables, roller tables, except hot strip run-out table; furnace pushers, pinch rolls, and screw-downs. The controls for these motors are all of the magnetic definite time limit acceleration type. Excepting for cranes, the control panels are arranged in groups in dust-tight brick rooms.

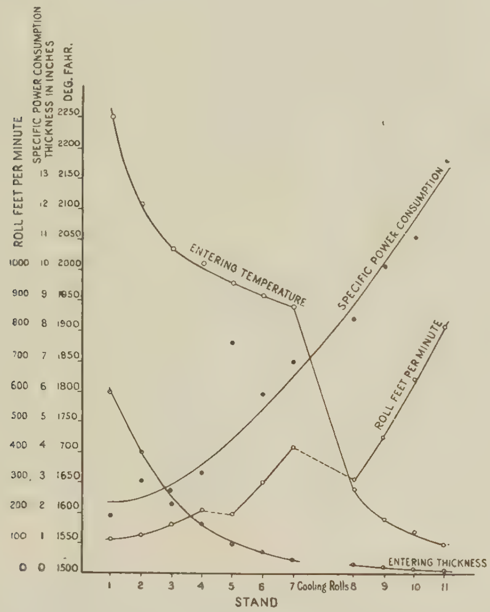

Fig. 6—Relative Values at Each Stand of Roll Speed, Specific Power Consumption, Thickness of Metal and Entering Temperature

Specific power consumption equals hp.-sec. per cu. in. of metal displaced

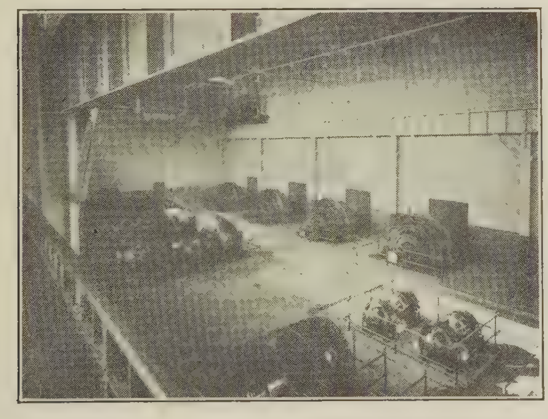

Fig. 7—Hot Strip Mill Motor Room

This room also houses the motor-generator sets and main control switchboard

Power for operating the new mill is purchased from the local power company at 66,000 volts. Service is over about four miles of double circuit steel tower line from the power company's substation at Trenton to a step-down transformer station at Middletown, built and owned by The American Rolling Mill Company.

Automatic oil circuit breakers are provided in the line at the 66,000-volt substation at Trenton and at the 6600-volt bus at the mill. Normally a 66,000-volts line transformer bank and 6600-volt line form an independent unit. No switching is done at 66,000 volts at the mill. However, disconnects are provided for isolating transformers and lightning arresters, and provision is made for adding oil switches when required.

The main bus for distribution of power at 6600 volts is in two sections. Each section is supplied by one of the transmission units. Feeders are so arranged on the bus sections that one section may be taken out of service for additions or repairs without a complete shut down of the mill. The two bus sections are tied together by a non-automatic oil circuit breaker.

Fig. 8—600-Volt D-C. Aluminum Bus Structure

In basement of hot strip mill. The supports are ebonized asbestos in welded steel frames

All 6600-volt circuits are protected by induction type overload relays. The two incoming lines are equipped with balanced reverse power and overload relays. These lines are similarly equipped at the power company's substation and, in addition, have ground relays. By means of this system, either transmission line is immediately switched off at both ends if it develops any trouble other than a single-phase ground on the 66,000-volt line. In the latter case, the circuit is opened automatically at the power company's substation, and an alarm is sounded at the mill to notify the operator to open his switch by hand.

The 600-volt direct current for main mill motors is supplied by three 4000-kw., three-unit synchronous motor-driven motor-generator sets. The 250-volt direct current for auxiliary motor circuits is supplied by two 750-kw. motor-generators sets, and 250-volt excitation by a 300-kw. motor-generator set. The excitation may also be supplied from the 750-kw. motor-generator sets.

Each 4000-kw. 600-volt motor-generator set consists of two 2000-kw. 600-volt generators rigidly coupled to a 5800-hp., 85 per cent power factor, 6600-volt, 60-cycle, 14-pole synchronous motor. One of these units is shown in Fig. 9.

The field of each 2000-kw. generator is arranged for 125-volt excitation. The fields of the two generators are connected in series and excited from a 250-volt constant voltage excitation bus. These generators have straight differential and crossed cumulative series fields, assuring equal division of the load between the two generators of the set. The three sets are operated in parallel by the use of double-pole equalizers between sets.

The two 750-kw. 250-volt generators are driven by 1080-hp., 900-rev., per min., 80 per cent power-factor synchronous motors, and the 300-kw. 250-volt exciter

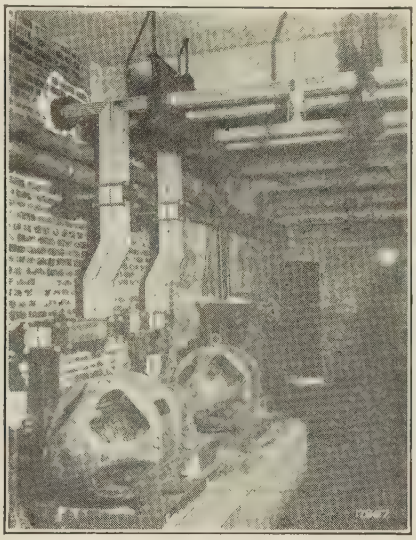

FIG. 9—SERIES EXCITER SET AND 600-VOLT D-C. ALUMINUM BUS STRUCTURE

by 432-hp. 1200-rev. per min. 80 per cent power-factor 6600-volt synchronous motor.

The 220-volt., three-phase power for auxiliary motors is from two automatic substations located near load centers. Each consists of a bank of three 200-kv-a. 6600/220-volt transformers and two automatic reclosing 1200-ampere, 220-volt, three-phase feeder panels. A tie connection is run between substations to carry part of substation load in the event of transformer failure.

The 250-volt d-c. system is supplied through automatic reclosing feeders from the 250-volt bus in the power distribution station. This bus is connected by tie lines to two other 250-volt d-c. generating stations in the plant.

Lighting is provided by an overhead system of lights suspended from a messenger wire. The messenger wire suspension prevents lamp breakage due to vibration of buildings, and permits arranging units for uniform light distribution.

Illumination values (foot-candles) are as follows:

Bar plate mill	3.5
Hot strip mill	3.5
Warehouses	3.
Switchboard and motor rooms	6

Provision is made for emergency lighting so that in case of failure of the 60-cycle service a system of emergency lights is automatically thrown on to storage battery service until the station operator can transfer the main lighting to a bank of transformers connected to the plant 25-cycle system.

Branch circuits are protected by circuit breakers with direct-acting time limit feature.

Lighting fixtures are individually fused and are arranged with a disconnecting device for ease of replacement and maintenance.

Both motor rooms are ventilated with filtered air. In the bar mill motor room the air is delivered by a 57,000-cu. ft. per min., 1¼-in. single-phase fan to the basement and thence to the pits under the motors. The air is filtered by two 30,000-cu. ft. per min., rated, rotary type air filters. The system is so arranged that all or part of the air may be recirculated and also may be heated by passing through a group of unit type steam heaters.

The hot strip motor room is ventilated by two 70,000-cu. ft. per min. 1½ in. single-phase fans which take care of the heat losses from motor generators, and two 65,000-cu. ft. per min., 3-in. single-phase fans which supply the forced air ventilation for the mill motors in this room. The air is cleaned by six 50,000-cu. ft. per min. rotary type air filters and may be recirculated and heated when necessary.

The grounding system is complete in all parts of the system.

Insulating mats are provided in front and rear of all switchboards.

A safety switch is installed in the leads of all motors, at the motors, so that when repairs or adjustments are made to the machines driven by such motors the switch may be opened and so make it impossible for others to start motor.

The electrical work in this mill was designed and constructed by The Dwight P. Robinson & Company, Inc., under the direction of The American Rolling Mill Company, which is the owners of the patents involving many of the mechanical features, as well as the rolling process in the above description.

More than 70 members of the women's division of the Electric Association of Chicago have registered for a course in electrical home making which is now being conducted. The course includes lectures and demonstrations of the use of all the usual household devices operated by electricity, including lighting, heating, and motor-operated appliances.

Abridgment of

Effect of Transient Voltages on Power Transformer Design

BY K. K. PALUEFF*

Associate, A. I. E. E.

Synopsis.—When an ordinary transformer is subject to transient voltage excitation, local concentration of voltage takes place in which the capacitance charging current of the coils to ground is supplied through the winding. This is because the ratio of inductance and capacitance of the various parts throughout the winding is not constant. Calculations and tests of voltage distribution in the winding, caused by the impact of (a) damped high-frequency oscillations, and (b) unidirectional traveling waves, are given. In order to make the analysis clearer, the transformer winding is considered as a network of inductances and capacitances, and this term "network" is used throughout the paper. Certain simplified and typical networks are considered.

Transformers having one terminal grounded, such as are used in three-phase star connection, particularly in high-voltage systems, are frequently built with the insulation graded to other windings and ground, in the order of the normal frequency voltage stress. The danger of such a practise is shown in power transformers which are subject to transient overvoltage, since voltage oscillation in the winding may raise the voltage to ground at intermediate points above the terminal voltage, unless the design of the winding eliminates oscillation.

The theoretical and experimental data given show that the distribution and magnitude of voltage stresses existing during recognized standard insulation tests are essentially different from stresses created by transient voltages. This permits the construction of transformers that would satisfactorily pass standard insulation tests but at the same time would not be suitable for average service.

A new type of a transformer called "non-resonating," for use on grounded neutral systems, is described.

In transformers of this type, voltages of all frequencies distribute uniformly along the windings, as the possibility of internal voltage resonance is eliminated by a proper balance of distributed capacitance and inductance of the winding.

This is accomplished principally by means of conducting surfaces (shields) placed outside of the winding and connected to its line terminal.

The action of the shields is similar to that of the shielding ring on an insulator string. It neutralizes the effect of the capacitance current from the inside surface of the winding to ground, by supplying to every point of the winding a "charging" current equal to the "discharging" current of that point to ground. In some cases, the application of the shield reduces the local stresses to one-eightieth.

Up to the present time, the total capacity of this new type of transformer exceeds half a million kv-a.

If the problem of designing the transformer insulation were limited to the requirements of normal frequency dielectric stress, it would be relatively simple.

It is not, however, the normal voltage stresses which, in high-voltage transformers, require the most careful consideration to predetermine the amount, kind, and arrangement of the insulation, but the transient stresses set up by abnormal conditions on the circuit.

The necessity for extra insulation, above that required to meet the A. I. E. E. test (or any other recognized standard rules) is due to two facts:

1. Transformers, even of high voltages, are subject to transient voltages many times the normal circuit voltage to ground. Records show from 10 to 15 times normal voltage to ground even on 220-kv. systems.

2. Most transient voltages are high-frequency oscillations, or are traveling waves lasting a number of microseconds, and the ordinary transformer does not permit these voltages to be uniformly distributed throughout the winding. This is because the transformer winding is not a pure inductance, but also contains distributed capacitance.

To determine the effect of the above considerations on the transformer design two alternative designs of 20,000-kv-a., 220,000-volt transformer were prepared Both alternatives were to satisfy identical operating characteristics as efficiency, reactance, potential test, etc.

The first design was made in accordance with the A. I. E. E. Standards, as well as transient voltage requirements developed by the years of experience and incorporated into practise for at least ten years.

The second design was made in accordance with A. I. E. E. Standards only.

The comparison revealed that first transformer cost 40 per cent more than the second and has 75 per cent more of active material than the second.

It is important to note that the second transformer would withstand successfully not only the tests called for by A. I. E. E. Standards but also all the tests called for by any other recognized standard rules including those which specify so called "surge or impulse test." This is because such tests impose on transformers transient voltage of an amplitude negligible in comparison with those experienced in actual service.

With the assistance of two previous papers,[1,2] and much additional study and experiments, a new type of transformer has been developed, for operation with solidly grounded neutral, which is believed to be better adapted to resist stresses caused by voltage transients than any type used heretofore.

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1. A. I. E. E. TRANS., Vol. XXXVIII, p. 577.
2. A. I. E. E. TRANS., Vol. XLI, p. 149.

Equivalent Networks

Most engineers, who deal with electrical phenomena of commercial frequencies only (25 to 60 cycles), picture to themselves inductance as a spiral wire, and capacitance as two parallel plates, and therefore are not apt to recognize these characteristics when they are disguised in different geometric forms. Furthermore, again due to everyday experience with low frequencies, they are accustomed to think of some apparatus (such as transformers and choke coils) as pure inductances, and of others as pure capacitances (parallel plates, synchronous condensers), or as resistances. To discard

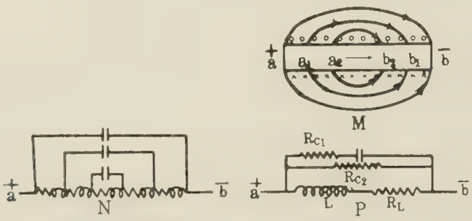

Fig. 1—Equivalent Circuit of a Simple Conductor

these faulty notions is the first step toward the understanding of transient phenomena.

A straight piece of conductor, no matter how small and regardless of its material, is not a pure resistor, but is equivalent to a complicated network of elementary condensers, inductances, and resistances such as shown in Fig. 1.

Ordinary Transformer

Equivalent Network. At operating frequencies, transformers act as inductances in series with some resistances. But, as was shown above, no apparatus or any part thereof can be free of capacitance,—therefore the capacitance must be present in the transformer.

Taking each separate coil (disk or pancake) as an element, a transformer equivalent network becomes as shown in Fig. 3.

The network shown in this figure lacks negative inductance links representing mutual inductance between various parts of the winding. Whenever calculated results of a transformer's behavior are given in this paper, the effect of mutual inductance is properly taken into account.

The Cause of Voltage Resonance in a Transformer. In case the winding is uniform in its construction, the constants of the equivalent circuit will be uniform, and a definite relation between the magnitude of succeeding voltage resonance frequencies can be expected.

The fundamental natural frequency of transformers ranges from about 1000 to 60,000 cycles, and their harmonics of practical importance reach 750,000 cycles.

It so happens that the natural frequency of circuits connected to the transformer in service range between the same limits as do the natural fundamental and harmonic frequencies of transformers.

Referring to network C of Fig. 3 of an ordinary winding, we find that while inductances L, as well as series or internal winding capacitances C_w, are all alike, the capacitances C_s, from the surface of the winding to ground, (the "shunt" capacitances) in spite of their being alike among themselves, make reactances of elements $a\ b$, $b\ c$, $c\ d$ differ from one another, thereby causing voltage resonance conditions.

Should capacitances C_s, therefore, be removed, or their effect on the winding be neutralized in some manner, the reactance of all the elements of network C, (Fig. 3) will become one and the same; and as such a circuit is incapable of voltage resonance, voltage of all frequencies will distribute along it uniformly.

This conclusion is of fundamental importance.

Initial Voltage Distribution with Rectangular Traveling Wave. It was shown above that a transformer has two parallel paths from one terminal to another, one a pure inductance and the other a pure capacitance. This means that at very high frequency the current will follow the capacitance path, and at low frequency, the inductive path.

A sufficiently steep front of a traveling wave corre-

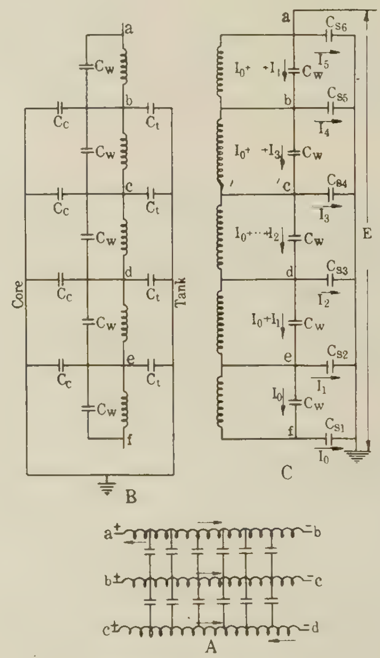

Fig. 3—Transformer Equivalent Network

A. Network of adjacent turns
B. Network of entire winding.
C. Simplified B.

sponds to a quarter of a cycle of a very high frequency, and therefore its current will follow the capacitance path alone. This means that during the rise of terminal voltage from zero to crest of the wave, no current will flow along the conductor, and the transformer will act though every turn is disconnected from the adjacent one; that is, as a pure condenser. This state is called here the initial, or electrostatic. (See Fig. 20).

The condition of voltage concentration at the line end of a string of insulators is well understood. In a similar way, in the transformer it is caused by the presence of the shunt condensers, because the current

of the shunt condenser must flow through the series condenser as shown on Fig. 3. Therefore, starting at the ground end, each succeeding series condenser C_w carries more current than the preceding one. As all series condensers are alike, it is obvious that the magnitude of their voltages will correspond to magnitudes of their currents.

The concentration of voltage will be the greater, the

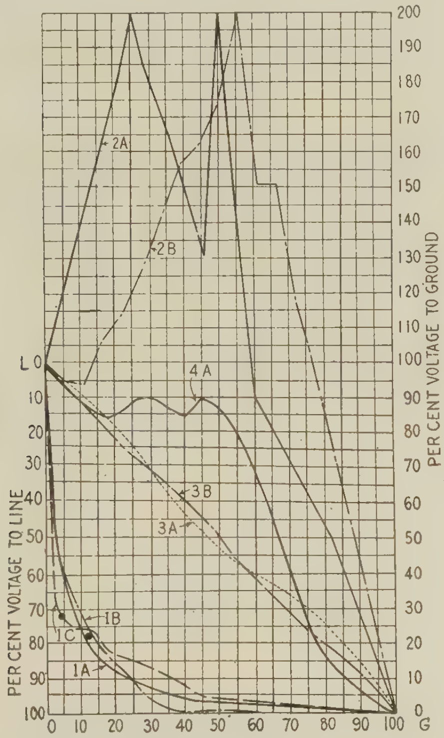

Fig. 20—Voltage Stresses Measured in Transformers Under Test

Transformers tested: (A), core type; (B), core type; (C) shell type.
Non-Shielded
Curves 1A, 1B, 1C: Initial voltage distribution with traveling wave on transformers *A*, *B* and *C* respectively (without entrance bushing). (Dots indicate measured voltages on *C* with entrance bushing).
Curves 2A and 2B: Envelope of voltages in transformers *A* and *B* produced by damped oscillations.
Curve 4A· Envelope of oscillations caused by traveling wave on transformer *A*.

Shielded (Non-resonating)
Curves 3A and 3B represent envelopes of all voltages caused by damped oscillations from 3 to 1000 kc. as well as steep front traveling waves on transformers *A* and *B*, respectively.

greater the shunt capacitance in comparison with series capacitance.

b. Voltage Distribution during Oscillation. Assume for the time that the traveling wave is infinitely long and therefore its crest acts on the transformer network (Fig. 3) as d-c. voltage, and thus chooses the inductance path for its current. The permanent or "final" voltage distribution will be perfectly uniform and appear as the straight line *L G*, (Fig. 20).

The difference in initial and final states is apparent and will cause a transient state which will consist of a number of sinusoidal oscillations of various frequencies and amplitudes superimposed on one another.

It can be shown that the axis of oscillation is the final state of a given point in the winding, while its amplitude is the sum of the amplitudes of all natural frequencies of the circuit.

Traveling Wave with Slanting Front.

a. Initial Voltage Distribution. From the discussion of initial voltage distribution due to rectangular front an impression may be gained that a very steep front is necessary to create a purely electrostatic field in the winding, and therefore the concentration of voltage at the line end of the winding cannot be experienced in practise where rectangular waves do not exist.

b. Voltage Distribution during Oscillation. Fig. 24 illustrates the effect of the length of the wave-front on voltages created by the oscillation following the initial state.

Curves 1, 2, 3, and 4 show the rise of voltage above ground at the middle of the transformer winding, caused by voltage waves at the transformer terminals as shown by curves 1a, 2a, 3a, and 4a, respectively.

There is practically no difference between the maximums of curves 1 and 4, in spite of the great difference between the exciting waves 1a and 4a. It should be noted that the 4a wave has a front of 30 microseconds.

Wave with Steep Tail.

If a traveling wave with a steep tail, such as would be caused by an insulator flashover, strikes a transformer, severe internal stresses may be set up in the latter if it is of the ordinary design.

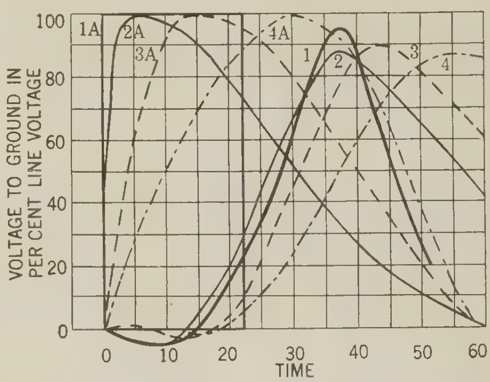

Fig. 24—Effect of Slanted Front on Oscillation of Middle of Winding of Transformer B

1 A, 2 A, 3 A, and 4 A—voltage at transformer terminals
1, 2, 3, and 4—voltage at the middle of winding

Transient Voltages in Practise

Upper Limit of Transient Voltages.

Laboratory experiments, completely substantiated by service records, show that on most of the existing transmission systems transient voltages reach values beyond the dielectric strength of the line insulation. Many lightning waves of crest values equal to 10 times normal line voltage, and a few up to 15 times normal voltage and switching surges up to 8 times normal have been recorded.

5. Conclusions.

The following table shows the order of magnitude of voltage stresses produced between different elements of a transformer winding having one end permanently grounded. Column I gives stresses produced by the standard Induced Voltage Test. Column II gives the dielectric strength necessary to withstand service transients produced in a uniform winding.

In the numerical example, Column III, the minimum values (in kv.) are given for a typical transformer to be operated on a 220-kv. system.

The voltages in Columns I and II are given in terms of effective value E, which is the normal operating line to neutral voltage of the transformer.

	I	II	III
High-voltage line end to low voltage and ground	3.46 E	3.46 E	440 Kv
Any other point between line and ground end p % away from ground end	p E	3.46 E Unless p is less than 10%. Some reduction is permissible for p less than 10%.	
Turn ins. of line coil. .	100 to 600 V.	0.63 E	80
Turn ins. near line coil	100 to 600 V.	Gradually reduced from 0.63 E to 0.20 E	
Turn ins. in the main part of the winding. .	100 to 600 V.	0.20 E	25
at ground end.	100 to 600 V.	0.35 E	44
Coil to coil at line end. .	0.04 E	1.3 E	165
Coil to coil near line end	0.04 E	Gradually reduced from 1.3 E to 0.65 E	
Coil to coil in the main part of the winding.	0.04 E	0.65 E	82
near ground end. . .	0.04 E	0.88 E	110

The difference between values of the first and the second columns is responsible for the difference in cost and volume of 20,000-kv-a. 220-kv. transformers referred to in the Introduction.

Part IV

Protection Against Transient Voltages

1. Non-Resounding Transformers.

a. Theory. It was shown above that the cause of non-uniform voltage distribution along transformer windings was due to the presence of shunt capacitance (C_s in network 3 of Fig. 3), because, due to this shunt capacitance, damped (or sustained) oscillations of a series of frequencies, applied to the terminals of such a network, cause different parts of it to get in voltage resonance and produce over-voltages shown by the curves (2 A, 2 B of Fig. 20).

In the case of traveling waves, the same shunt capacitances were found to be responsible for internal over-voltages, as the initial and final voltage distributions were different because the charging current of all shunt capacitances were supplied through the series capacitances, causing concentration of voltage at the line end at the time of impact of the wave.

With the effect of shunt capacitances neutralized, there would be no shunt current to be supplied by any series capacitances, and as they are all alike, the initial voltage would be uniform. The final voltage distribution also will be uniform, as all elementary inductances are alike and therefore there will be no transient.

Referring to A of Fig. 25 on the left side of the transformer equivalent network a new system of shunt condensers C_P is shown. This system, however, is not connected to ground as C_s are, but to the line terminal.

It is obvious that values of each capacitance (C_P) can be selected so that with the voltage uniformly distributed throughout the winding, the current

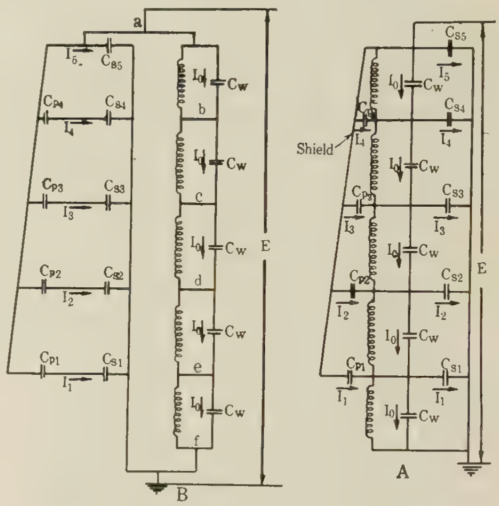

Fig. 25—Equivalent Network of Shielded Transformer

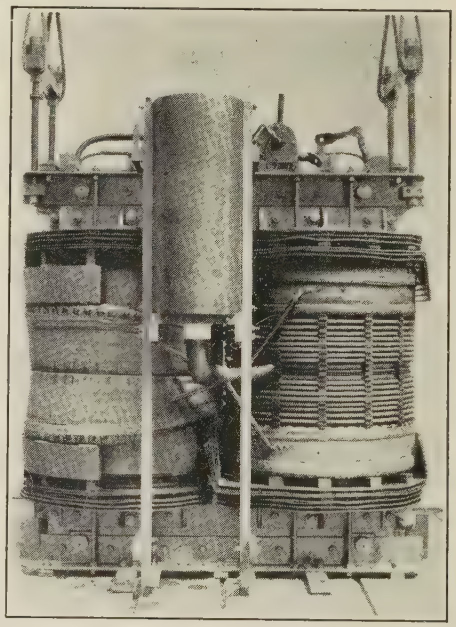

Fig. 29—Non-Resonating 20,000-Kv-a. 132,000-Volt Transformer

through respective C_P to a given element will be exactly equal to the current through the shunt capacitance C_S of that element to ground. In such a case, the charging current through all series capacitances will be equal

and the voltage across them alike. This would hold true, of course, at all frequencies.

As the protecting condensers are so proportioned that the voltage divides equally between the series capacitances, the initial voltage would be a straight line the final distribution is also a straight line (as all L's are alike),—therefore there can be no transient.

b. Test Data. Extensive tests were made on some power transformers with damped oscillations of frequency ranging from 3 to 1000 kilocycles, as well as with impulse waves of various shapes. The results are summarized on Fig. 20.

In practise, the condenser arrangement C_P consists simply of a smooth metal surface or a small number of such surfaces properly spaced and insulated from ground and the windings, and connected to the line terminal of the protected winding. These surfaces are called "shields."

They are located on the outside of the high-voltage windings, so as not to interfere with its usual construction. Fig. 29 shows a power transformer of the non-resonating type. So far, the non-resonanting type has been adopted for more than half a million kv-a. of transformers.

3. Effect of the Transformer Bushing.

The capacitance of the bushing is in shunt with the transformer, and is of the order of 0.0002 microfarads, which corresponds to the capacity of 0.15 of a mile of transmission line. This value is so negligibly small that it can have no effect on transient voltages within a transformer.

4. Choke Coils, Current Transformers, etc.

When a concentrated inductance such as a choke coil, current limiting reactor, current transformer, etc., in series with transformers, is struck by a traveling wave of steep front or tail, it enters into oscillations with the electrostatic capacity of the transformer. In this way, dangerous internal voltages may be set up in the transformer if it is of the ordinary design.

The author wishes to acknowledge here that in the preparation of this paper the interest and assistance of Mr. F. F. Brand have proved invaluable. The valuable assistance of Mr. J. H. Hagenguth in the preparation of data is also recognized.

Abridgment of

Street Railway Power Economics
On the Cincinnati System

BY J. A. NOERTKER*

Associate, A. I. E. E.

Synopsis.—*Within the past few months, the Cincinnati Street Railway Company has completed the rehabilitation of its entire power system. The system now consists of 19 full automatic synchronous converter substations upon which has been superimposed a complete system of supervisory control and remote metering. Papers have been presented by Frank W. Peters and Harley L. Swift, covering the details of this installation.*

This paper discusses the economic factors involved in the selection of equipment and the design of the system. Part I points out that the most important economic consideration is service and presents a method for evaluating this factor. Part II discusses the design of feeder circuits with particular reference to the limitations of Kelvin's Law. Part III discusses system design with reference to the economics involved in the location of substations, and in the selection of control equipment. A general method for conducting extensive system studies is implied. Part IV discusses system load-shifting characteristics and Part V points out the advantages of supervisory control.

Introduction

THE management of a modern street railway system, especially one operating under a "service at cost" franchise, should and does aim to provide a service that most nearly meets the requirements of the average car-rider; which implies, the fastest schedule speeds consistent with safety and ultimate economy. As a matter of fact, ultimate economy, as it concerns both car-rider and company, is one of the most important considerations.

The car-rider is interested in continuity, cost and quality of service. The primary factor affecting the quality of service is speed of car operation, and some idea of the magnitude of this factor may be had by considering that in a city of the size and character of Cincinnati, the total annual time spent by the car-riding public in transportation is approximately 50,000,000 hr.

It is practically impossible to determine definitely a value for this time; however, assuming a rate of 50 cents per hour, the annual amount will be $25,000,000, which amount is of sufficient magnitude in the interest of both the car-rider and the management to urge a careful analysis of all factors affecting the speed of car operation. Among the many factors affecting the

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29-48

speed of car operation, outstanding are: (1) Topography; (2) traffic congestion and control; (3) number and duration of stops; (4) rates of acceleration and retardation; (5) motor characteristics; (6) trolley voltage.

Two of these factors, motor characteristics and trolley voltage, are directly under the control of the railway engineers. In selecting car equipments, it is necessary to assume average conditions of the above factors. The proper voltage has also usually been determined for average conditions and in the design of the power system the effort has been to furnish this average voltage over the entire system. It is not certain, however, that an average voltage will fulfill all conditions in the most effective manner. Since the primary function of the power system is to furnish the most economical and satisfactory trolley voltage for the operation of the cars, it is of first importance to determine what voltage or voltages are the most economical and satisfactory for various operating conditions and then provide such voltage through the means of variable converter characteristics and transformer taps.

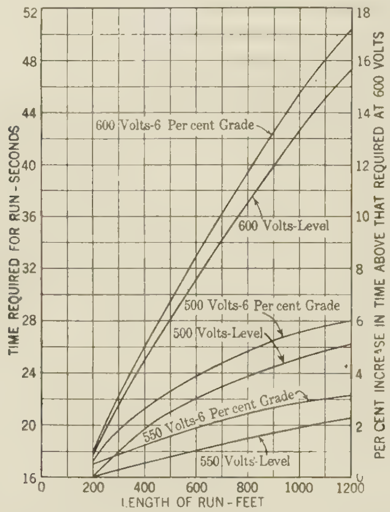

FIG. 1—MINIMUM TIME REQUIRED TO MAKE VARIOUS RUNS (WITHOUT COAST) AT 600 VOLTS, AND PERCENT INCREASE IN TIME AT LOWER VOLTAGES

Car Data—Motors—4 W. E. No. 510 E. hp. 35
Gear Ratio—13.69
Size of Wheels—26 in.
Wt. of Car and Load—19.36 tons
Acceleration—1.5 mi. per hr. per sec.
Retardation—2.0 mi. per hr. per sec.

While poor voltage conditions may result in loss of time by passengers, aside from the evaluation of this time, it can be shown that for a city the size of Cincinnati, the annual variable cost of power supply subject to manipulation on which there is no practical check is approximately $180,000.00. This is made up of carrying charges on feeders, conversion loss, demand loss, energy loss, and carrying charges on that portion of the conversion equipment required to supply the feeder loss. From this fact alone it is evident that a thorough study of the power system is justified.

In an effort to determine the proper voltages for the operation of cars under various conditions, the following curves have been plotted from the data derived from speed—time and power—time curves of the latest type cars of The Cincinnati Street Railway Company.

Fig. 1 shows the minimum time required to make various runs at 600 volts and the per cent increase in time at lower voltages. It will be observed that for runs of less than 200 ft., the minimum time required to make the run is approximately the same.

Fig. 2 shows the energy consumption required to make various runs at several different voltages. The curves show that increasing the voltage on these runs materially increases the energy consumption.

Fig. 3 is derived from Figs. 1 and 2 and presents the same information in a more convenient form for a 300-ft. level run and a 1200-ft. run on 6 per cent grade.

Fig. 4 shows the most economical trolley voltages for a 300-ft. level run and a 1200-ft. run on 6 per cent grade, with platform expense and evaluated time of car-rider taken at $10.00 per car hour and energy cost at the car taken as 1.5 cents per kw-hr.

Inasmuch as increased car speed has been looked upon as the desirable result of increasing trolley voltage, no consideration has been given to the effect of coasting.

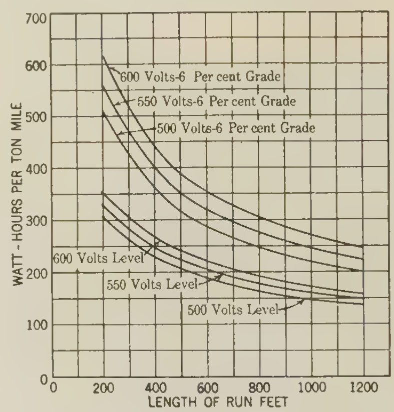

FIG. 2—ENERGY REQUIRED TO MAKE VARIOUS RUNS (WITHOUT COAST) AT VARIOUS VOLTAGES

Car data—same as Fig. 1

II. DISTRIBUTION SYSTEM

Feeder Sizes. The application of Kelvin's Law to railway power circuits has been presented in a paper by Crecelius and Phillips. (See Bibliography, complete paper). The following equations and curves present a convenient method for applying this law to extensive system studies. The most variable factor in such a study has been considered to be the cost and value of installed copper.

The total annual cost of a feeder circuit is equal to

the annual investment charge plus the annual demand loss charge plus the annual energy loss charge. This may be expressed as a mathematical statement as follows:

$$C_p = (r_1\, Cu\, 10^{-2})\,(3.67\, m\, D\, 10^{-6}) + \left(\frac{M + r_2\, C_s\, 10^{-2}}{\text{Eff. (s. p.)}}\right)\left(\frac{I^2\, 11.0\, D\, 10^{-3}}{m}\right) + \left(\frac{e}{\text{Eff. (av.)}}\right)\left(\frac{8760\, I^2\, 11.0\, D\, L\, 10^{-3}}{m}\right) \quad (1)$$

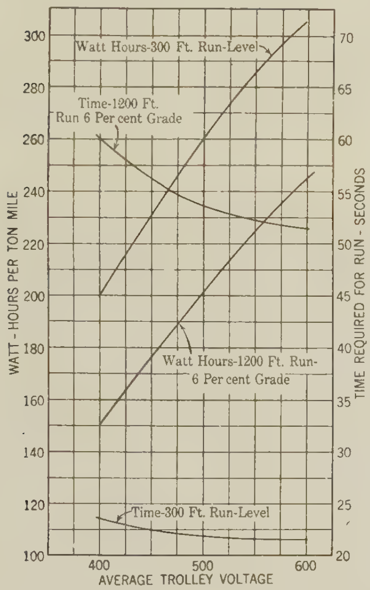

FIG. 3—TIME AND ENERGY CONSUMPTION REQUIRED (WITHOUT COAST) FOR 300-FT. LEVEL RUN AND 1200-FT. RUN ON 6 PER CENT GRADE

Car data—same as Fig. 1

where

C_p = Total annual cost of positive feeder circuit (dollars)

r_1 = Rate of return on feeder investment (12 per cent). (Taxes 2.0 per cent; Depreciation 2.0 per cent; Interest 6.0 per cent; Reserve 2.0 per cent)

Cu = Cost of insulated feeder in place (dollars per lb.)

3.67 = Pounds per ft. 1,000,000-cir. mil cable triple braid, weatherproof insulation

m = Cross-section of feeder at substation end (cir. mils)

D = Distance in feet to end of feeder or neutral point of feeder common to two or more stations

M = Annual maximum demand charge (dollars per (a-c.) kw. metered at 13,200 volts—$12.00)

Eff. s. p. = Efficiency of substation during peak load (0.93)

r_2 = Rate of return on substation investment (15 per cent). (Taxes 2.0 per cent; Insurance 0.5 per cent; Depreciation 4.5 per cent; Interest 6.0 per cent; Reserve 2.0 per cent)

C_s = Cost of substation per (d-c.) kw. capacity ($40.00)

I = One hour maximum demand (amperes)

11.0 = Ohms per cir. mil ft. 30 deg. cent. 98 per cent conductivity

e = Energy charge on purchased power (dollars per (a-c.) kw-hr. $0.004)

Eff. (av.) = Average efficiency of substation (0.90)

8760 = Hours in a year

L = Loss factor—the ratio of the average of the squared current demands to the squared maximum hourly current demand (0.25)

Substituting the above values in the equation for total annual cost and combining terms, the equation reduces to

$$C_p = 0.44 \times 10^{-3}\, Cu\, m\, D + \frac{0.32\, I^2\, D}{m} \quad (2)$$

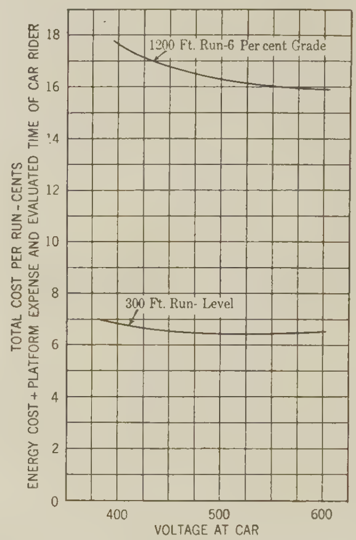

FIG. 4—TOTAL COST FOR SEVERAL RUNS (WITHOUT COAST) AT VARIOUS VOLTAGES

Car data—same as Fig. 1
Energy Cost—1.5 cents per kw. hr.
Platform expense and evaluated time of car-rider $10.00 per car-hr.

Equating first derivative to zero for minimum annual cost

$$O = 0.44 \times 10^{-6}\, Cu\, D - \frac{0.32\, I^2 D}{m^2}$$

$$m = \frac{850\, I}{\sqrt{Cu}} \quad (3)$$

This is the proper size feeder for minimum annual cost for concentrated load at the end of a feeder of uniform cross-section.

Copper losses caused by a distributed load on a theoretically tapered feeder are equal to one-half those

caused by a concentrated load on a feeder of uniform cross-section if this cross is the same as that at the station end of the tapered feeder. Since the volume of the tapered feeder is one-half that of the uniform feeder, the investment charge is one-half that shown by the equation for the uniform section with concentrated load.

The annual charge for this type of feeder is

$$C\,p = \frac{0.44 \times 10^{-6}\,Cu\,m\,D}{2} + \frac{0.32\,I^2\,D}{2\,m} \qquad (4)$$

and the cross-section for minimum cost becomes

$$m = \frac{850\,I}{\sqrt{Cu}} \qquad (5)$$

Also, since it can be shown mathematically that the copper losses caused by a distributed load on a feeder of uniform cross-section are equal to one-third those caused by a concentrated load, the annual charge for such a feeder is

$$Cp = 0.44 \times 10^{-6}\,Cu\,m\,D + \frac{0.32\,I^2\,D}{3\,m} \qquad (6)$$

and the cross-section for minimum annual cost becomes

$$m = \frac{850\,I}{\sqrt{3}\,\sqrt{Cu}} = \frac{490\,I}{\sqrt{Cu}} \qquad (7)$$

It is of particular interest to note that the proper size feeder for minimum annual cost, equation (3) is directly proportional to the load, and does not depend on the length of the feeder. All of these equations are applicable to the positive feeder circuit on both single and double trolley systems.

Reconcilement to Kelvin's Law. After feeder sizes have been determined by Kelvin's Law, the resulting average feeder voltage should be checked against the most economical voltage required for the operation of the cars. If the average voltage at the load as determined by Kelvin's Law is considerably above or below that required for the most economical car operation as shown by curves similar to those of Fig. 4 for the average runs on the section in question it will be necessary to plot graphs of equation (2) (total annual cost against average voltage at the load). This graph should then be superimposed and added to the appropriate curve on Fig. 4. The resulting graph will indicate the point of over-all minimum cost. The corresponding feeder size can then be read directly from the curves.

Tie Feeders. A comparison of equations (9) and (10) shows that the total annual cost of the uniform cross-section feeder is 15.7 per cent higher than that of the tapered section. In actual practise, due to the impossibility of obtaining a theoretically tapered section, this percentage is somewhat less. It is considered, however, that the advantages of the uniform cross-section feeder are worth the increased cost. This fact can be proved conclusively through the evaluation of power outages mitigated by the use of tie feeders.

III. Conversion System

Converter and Transformer Characteristics. It is evident that in so far as possible, the railway power system should provide the most satisfactory and economical trolley voltage. Since adjustment of voltage through the manipulation of the distribution system does not supply an economical method for varying voltages, it is up to the substation engineers to provide for this by making use of either adjustable machine characteristics or suitable transformer taps, or both.

There is no argument as to the superior performance of shunt converters from the standpoint of substation operation and system stability, but it must be recognized that shunt converters cannot be used in outlying territories or on heavy grades except at the sacrifice of car speed. In congested areas, advantage can be taken of the superior operating characteristics of shunt converters with the additional advantage of power saving brought about through the furnishing of more economical trolley voltages. For the same reasons, it will be desirable to provide transformer taps with the idea of varying d-c. bus voltage. Two distinct advantages resulting from this practise are (1) the providing of a more satisfactory trolley voltage, and (2) the providing for emergency load shifting.

Manual vs. Automatic Control. Among the important factors that determined the type of control selected for the Cincinnati power system were maintenance and operating costs; cost of equipment; reserve capacity; efficiency; reliability; improved service; protection of equipment and load shifting characteristics.

From a careful study of maintenance and operating costs and cost of equipment, it is apparent that automatic control has a decided economic advantage only in the case of new single unit stations.

Due to load shifting characteristics and thermal protective devices, automatic equipment can safely be subjected to heavier loads than could the corresponding manual equipment. Hence, it can be seen that less reserve capacity is required, and that efficiency may be increased. The reserve capacity required for double unit stations is particularly affected.

A definite improvement to service, due to automatic control, is the increased speed with which service is restored after having been interrupted by the failure of the high-tension power supply or by faults on the d-c. feeder system.

Since the bearing, thermal and ground devices on the automatic-control equipment provide protection superior to that possible with manual control, this must be considered an advantage.

The advantage of the load shifting equipment provided as part of the automatic control is one of the most outstanding benefits and should be given considerable weight in selecting control equipment for any railway application.

V. Supervisory Control

The primary functions of supervisory control are (1) to provide necessary checks on operation of substations, (2) to operate the system at the point of maximum efficiency and (3) to change the normal automatic functions so as to better meet emergencies.

Inasmuch as the entire 600-volt feeder system is tied together so that the loss of any one substation during the light load periods has little affect on the movement of cars, it is apparent that without some sort of indicating system, there is at this time no check on substation functioning. As most faults occurring in automatic substations develop or become apparent during the starting operation, it is of particular advantage to have a check at this time so that the faults may be remedied before the peak period.

Since the load demands on a street railway system are approximately the same from day to day, it is possible to calculate the most efficient way in which to operate the system. This will usually call for a definite schedule for the various units.

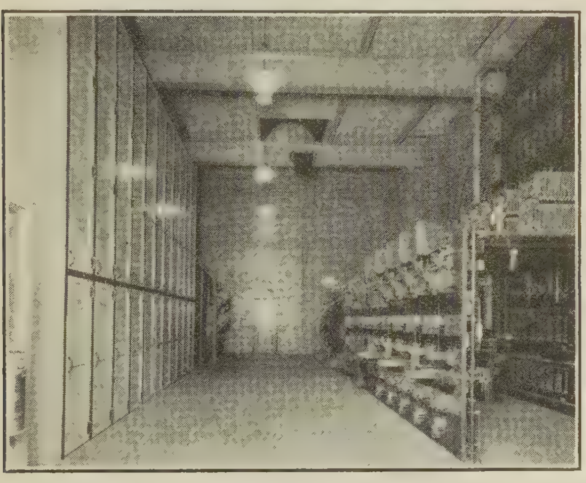

Fig. 11—Interior of Single Unit Automatic Substation

In addition to providing the means for meeting fire and storm emergencies, the supervisory system can often be used to meet emergency overload conditions. These are usually taken care of by automatic equipment through the cutting in of the load shifting resistance which, as before stated, results in power loss, impaired service, and the possibility of overheated resistors. Frequently, improved service will result from dropping tie-feeder loads, since this may permit the reclosing of the resistance shunting contactors.

Remote Metering. As applied to the Cincinnati power system, the remote ammeters provide the dispatcher with a continuous check on the operating conditions of the converters, both when starting and running. The ammeter, although calibrated to read in d-c. amperes, really measures the current in the a-c. side of the converter. The load readings are essential if the dispatcher is to shift loads during emergency overload conditions. The recording voltmeters provide a continuous check on that most important operating factor substation bus voltage.

Conclusion

Inasmuch as topography, arrangement of the city, density of population and traffic conditions have such a definite bearing on the distribution of load and car operation, it is impossible to draw conclusions that are generally applicable to all railway systems. In any city, however, the comprehensive design of a power system must consider as one problem the effect of trolley voltage on car speed, the distribution system, the location of substations and the selection of conversion equipment.

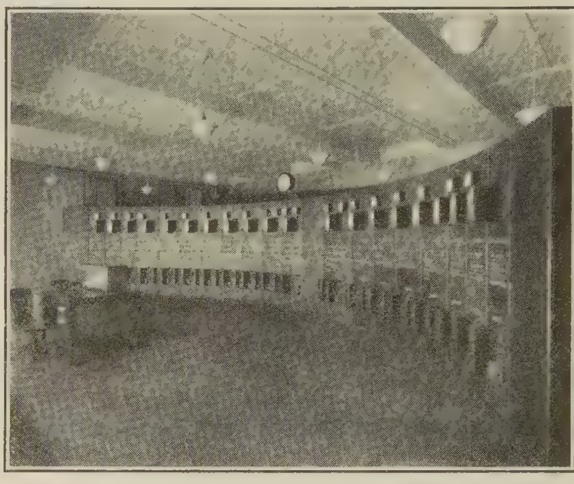

Fig. 13—Supervisory Control Room

a. On any railway system, the effect of trolley voltage on service is of most important consideration and merits a more extensive study than has yet been given to it.

b. Kelvin's Law with certain limitations is generally applicable to the design of railway feeders and offers a relatively simple solution to the problem of the determination of proper feeder sizes.

c. Converters and transformers designed to give the greatest possible flexibility as to operating voltage should be selected. Compound-wound converters capable of being operated as shunt machines are most suitable for the railway power system, the flat voltage characteristics being desirable for grades and outlying territories and the shunt characteristics being more desirable for congested areas.

d. The use of automatic control results in the most economical and reliable system.

e. With a complete automatically-controlled system it is necessary to have some sort of check on substation operation. Supervisory control, in addition to providing such a check, furnishes a method for more efficient normal and more effective emergency operation than is possible with full automatic equipment acting alone.

Abridgment of

Recent Development in Telephone Construction Practises

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and

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Synopsis.—In this paper are described recent developments in telephone construction practises which react to preserve the integrity of the sheath of lead-covered cable, thus decreasing insulation troubles due to moisture seeping through armor breaks and warding off serious service interruptions.

* * * * *

Introduction

GROWTH of the telephone plant in the last few years has naturally followed the tremendous increase in the use of this method of communication. The outside plant which has been built to satisfy these increased requirements is very largely composed of either aerial or underground cable.

The extension of the toll cable network, where in several hundred telephone and telegraph messages a carried within a lead-antimony cable sheath of approximately 2⅝ inch diameter, and the development of exchange cable in sizes up to 1818 pairs of wires, has necessitated new construction practises intended to keep the sheath intact, thereby lessening service interruptions.

These new construction practises are the results of development work throughout the country and are as follows:

1. Gas pressure testing of cable to locate sheath openings.
2. Methods of erecting aerial cable in order to minimize bowing.
3. Long span construction.

Gas Pressure Testing

With the extension of the toll cable network, it has become necessary to provide a definite plan of preventive maintenance whereby potential troubles may be eliminated. In this connection, the introduction of gas under pressure into a cable is not a new departure, but the kind of gas and the apparatus for applying it, have undergone considerable development and improvement in the past three years.

Equipment

Oil pumped nitrogen has been adopted as the most suitable gas for pressure testing. It is supplied by the manufacturer in 55-in. cylinders. These cylinders are usually used on large construction projects inasmuch as one 55-in. cylinder will test approximately 6000 ft. of full size cable.

In order that small amounts of gas may be available for testing single splices, a 25-in. cylinder which contains sufficient gas to test eight or nine 4½-in. sleeves is also used.

Standard gas pressure gages are used with these tanks and with the equipment shown in Fig. 1, they fit into wooden carrying cases which are issued to the splicers.

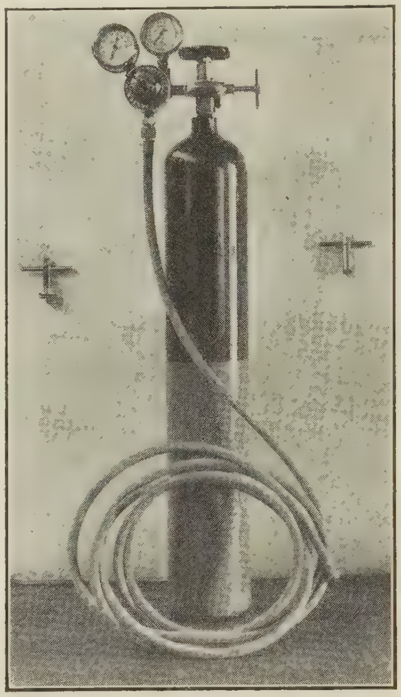

Fig. 1—Small Cylinder Gas Pressure Equipment

Showing regulating equipment valves and awl.

Single Splice Tests

In testing single splices, two holes are made with an awl, one near each joint end of the sleeve. A valve stem and a 30-lb. gage are screwed into these holes and the hose from the gas tank is attached to the valve stem. The entire sleeve and both joints are covered with thick soapsuds and then the gas turned on and allowed to flow into the sleeve at an ingress pressure of 40 lb. The gas is prevented temporarily from flowing through the cable by the paraffin in the cable ends which was deposited while "boiling out" the splice with hot paraffin to improve the insulation. When the pressure on the screw-in gage reaches 5 lb. the gas is turned off

1. Both of the Cincinnati and Suburban Telephone Company, Cincinnati, Ohio.

Presented at the Regional Meeting of the Middle Eastern District of the A. I. E. E., Cincinnati, Ohio, March 20-22, 1929. Complete copies upon request.

at the tank. The sleeve and joints are then examined with a magnifying mirror for bubbles which indicate leaks. Large leaks are located by the hissing of the escaping gas. If a joint leaks, it is rewiped and the gas testing operation is repeated.

Testing Long Lengths of Cable

On new cable projects, the usual procedure is to splice the cable in loading sections of 6000 ft. and to gas-test the section as a unit. Just before the loading is cut in, the ends of the section are capped and gages are installed at each end. At the loading point where the two ends of different sections appear, valve stems are fastened into the end caps and connected to a large cylinder of gas by means of a two-way hose. The nitrogen is permitted to flow into both sections simultaneously at a 40-lb. rate until the meters at the far extremities register 5 lb. The gas is then turned off and all meters are read as soon as possible.

If the reading at one end is appreciably different from that at the other, or if they are equal but lower than the average at the time the tank was disconnected, it is probable that one or more defects exist, and that they are in the duct line in the case of underground cable, or in the section between the splices on aerial cable.

Several methods of locating this type of trouble have been used with fair degrees of success. On aerial cable where it is possible to ride the entire section under test, the first step is usually to cover the section with the intention of hearing the hiss caused by escaping gas and to inspect the cable from the ground for any bends, kinks or flaws which would be soaped to locate possible troubles.

If this method is unproductive, the next step would be to install a gage in each splice in the section. As full size cable is usually erected in 750-ft. sections, there would be seven splices in a 6000-ft. section in which meters would have to be installed, making a total of nine points at which the internal pressure could be read.

The pressure readings would then be recorded on cross section paper. Theoretically, if the cable was free of defects, these points would lie in the same straight line and defects would be indicated by low points on the curve.

The curves shown in Fig. 2 give an example of the method of locating trouble in a typical 10-mi. section. From Curve 2-*A* defects exist in the vicinity of poles 980, 785 and possibly near 530. The defect near pole 980 will be located more accurately.

The method is to extend the converging slopes of the curve at the low point and the defect will be found near the location represented by their intersection. The readings at poles 1109, 1046, 980 and 915 are laid off to a larger scale (Curve 6-*B*) and the lines drawn through these points intersect near pole 1002. The foregoing represents an actual case, and the trouble was found in a leaky sleeve at that point.

This same procedure is used in locating defects in underground cable where the sheath break occurs in the duct line. The defect would be located between the manholes at which the lowest pressures are recorded.

Constant Pressure Testing

This system of pressure testing has been very effective and quite a number of the more important toll cables have been placed under constant pressure.

After the cable has been cut into service, all lateral taps and both terminal ends are sealed with dams or plugs to prevent the escape of gas. In addition to plugging the cable at the ends and lateral taps, intermediate plugs are installed at approximately 10-mi. intervals, in order to sectionalize the cable to assist in locating sheath breaks. Valve stems are first located

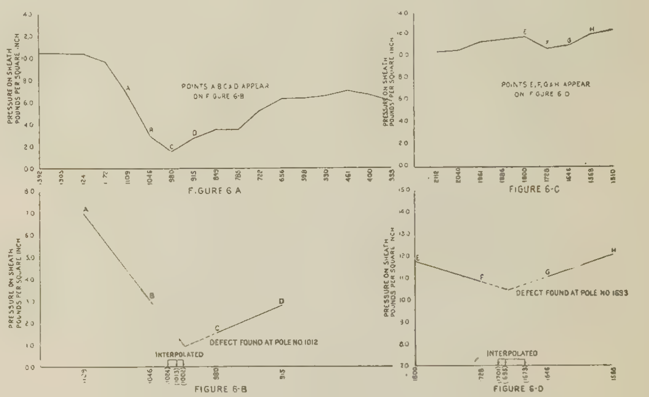

Fig. 2—Graphic Method of Locating Sheath Breaks

Typical pressure curve for section of aerial cable having two sheath breaks

Note: One 200 cu. ft. cylinder of nitrogen is sufficient to test a 6000 ft. section of cable

at the loading splices which gives them a 6000-ft. spacing. Enough gas is then introduced into the cable to give an equalized pressure of 15 to 20 lb. throughout the length.

In order to have a means of detecting loss of pressure after the section has been inflated for sometime, electrical indicating gages associated with an alarm circuit are placed in each ten mile section. The alarm is set to operate when the internal pressure falls below 12 lb. The alarm circuit operates a lamp signal or bell in the central office or repeater station and a cable man is immediately dispatched to locate the trouble by aforementioned methods.

Clearing Trouble

Another use of nitrogen in maintenance work results from the drying effect of the gas when admitted on either side of a wet cable fault. In certain instances, this method not only has restored the telephone service in a wet cable while a new section was being pulled in but it has aided the splicers in toning through the defective section when cutting over. It is reasonably certain however that only in those cases where the cable is partially wet, can it be dried out completely with gas.

Aerial Cable Construction

New methods which, it is felt, will decrease troubles

and lower maintenance costs have recently been developed for placing and splicing aerial cable.

Cause and Theory of Bowing

The causes of bowing in full sized aerial cable supported on 16-M suspension strand have been determined. Measures for the prevention of bowing have been worked out theoretically and have been put into practise in the field with satisfactory results. Fig. 3 illustrates a typical bow in a large cable.

The generally accepted theory of the cause of bowing is as follows: Due to a difference in the coefficients of expansion of suspension strand and cable, the cable expands more than the strand under the influence of a rise in temperature. The length of strand and cable in any span is assumed to be equal at the time the cable is spliced. As the temperature rises above the splicing temperature, the cable expands faster than the strand

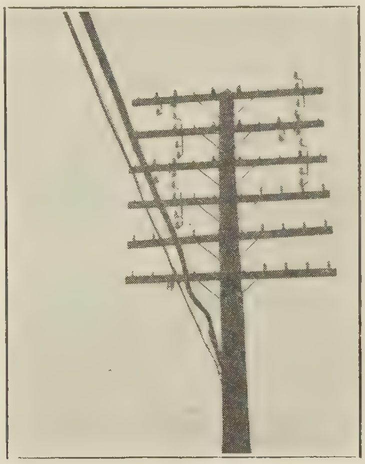

Fig. 3—Typical Bow in a Large Cable
This condition will eventually cause a sheath break at the wipe

and, as it cannot move along the line, compression is set up within the cable. When this compression exceeds the resistance of the cable to bending, the cable bows out of line. The amount of compression and bowing depends upon the extent to which the temperature has risen above the splicing temperature.

Under the influence of a drop in temperature, the cable will contract faster than the strand and when the temperature falls below that at which the cable was spliced, tension is developed in the cable. The tension which will develop at the minimum temperature of the locality depends on the temperature at which the cable is spliced. If the cable was spliced at a high temperature, the tension developed during extremely cold weather may stretch it permanently to some extent. As a result, when the temperature rises again to the original splicing temperature, the cable instead of being once more free of stress, will be under compression and as the temperature rises still further, bowing will occur sooner than it would have if it had not been permanently stretched.

Construction Methods to Minimize Bowing

As a result of studies and field trials of full sized cable supported on 16-M strand, the following construction methods have been recommended for new aerial cable so as to minimize bowing:

1. Reduced Strand Tension. This method is the reducing of the initial strand tension of 16-M strand from 6400 lb. (60 deg. fahr.) to 3600 lb. (60 deg. fahr). The theory is that a high initial strand tension reduces to a considerable extent the normal (or unstressed) elongation or contraction of the strand with temperature change. Therefore, if the initial strand tension is reduced, the loaded strand tension will be reduced and will permit an increased elongation and contraction with temperature change. As a result, the changes in strand length become more nearly equal to the changes in cable length, and the tendency for the cable to bow is reduced. Field trials have shown that the reduction in strand tension practically eliminated all bowing in those cases where the cable was spliced at a temperature of approximately 40 deg. fahr. or above.

2. Placing Strand at Correct Tension. In order to permit the field forces to string suspension strand more easily and more nearly at the correct initial tension, an instrument called the "Strand Dynamometer" has been developed. This instrument may be placed on the suspension strand at any point without cutting or otherwise injuring the strand and will indicate the tension existing in the strand at that point.

3. Placing Cable so that it is Free from Waves. In order to prevent bowing it is necessary to have the cable the same length as the strand when it is first placed in the rings. An "Aerial Cable Guide and Straightener" has been developed which eliminates in a large measure any waves which may be in the cable as it comes off the reel. The tool consists of a sheet iron shoe terminating in a steel tube of slightly larger diameter than the cable. The cable is pulled over this shoe and through the tube before it reaches the rings.

4. Preventing Cable from Being Spliced While the Strand is in a Stretched Condition. Splicing is ordinarily done from platforms which support one or two workmen and their equipment. This extra weight will stretch the strand and as a result, after the cable is spliced and the weight of the splicers and their equipment is removed, the strand will contract and some excess cable will remain in that span. This stretching of the strand has been prevented by supporting the temporary weight with a ladder which is tied to the strand alongside the splicing point before erecting the platform.

5. Placing Tension in the Cable. At temperatures of 40 deg. and below it has been found that the above measures are not sufficient to prevent the cable from bowing when the temperature subsequently rises to the neighborhood of 100 deg. fahr. Accordingly the practise has been developed of placing tension directly in the cable before splicing by means of a "Tension

Splicing Tool" and holding it there until the splice is completed.

The effect of tension is to reduce the amount of expansion in the cable and thereby bring the amount that the cable will expand under a given temperature rise closer to the amount that the strand will expand. The amount of tension placed in the cable varies with the temperature existing at the time the splice is made. For temperatures just under 40 deg. the tension is small, but for temperatures as low as 20 deg. below zero, the tension is about 1500 lb. This method has prevented bowing in cables spliced at temperatures as low as 5 deg. below zero.

Removing Bows in Old Cable

Two methods have been investigated for removing the bows in cable which has been erected and spliced for some time. They are:

1. Pull the excess length of cable to concentration points and cut out.
2. Cut suspension strand at intervals, introduce excess strand at these points, and slack off until bows disappear.

Where the bows are removed by cutting out the excess cable length, some tension remains in the cable after being pulled to the concentration points but the strand tension is not materially reduced. Therefore, during hot weather, the tension in the cable tends to reduce the bowing while the high initial strand tension tends to promote it. Consequently the results obtained in this matter are not as successful as the results obtained by slacking off the suspension strand at various intervals, which method places the cable in tension and reduces the strand tension simultaneously.

Another advantage of Method 2 over Method 1 is that slacking off the strand does not require that the working cable be opened whereas in pulling tension in the cable it must be cut to remove the excess length. Inasmuch as the comparative costs of the two methods are approximately the same, slacking off the strand appears to be superior to cutting excess length out of the cable, as a method for removing bows from cables supported on 16-M strand. Cutting the excess length out of bowed cables has its application to those cases where the strand tension is low, the cable is badly bowed, and the existing clearance above ground is such that no material increase in sag can be permitted.

Long Span Construction

A "Long Span" in the telephone plant refers to any span longer than the normal 150 ft. and ranging up to and in excess of 1000 ft. Due to the physical characteristics of telephone cable, especially its low tensile strength, it is necessary to support it with steel strand (called the "messenger") from which the cable is suspended by means of hangers spaced 20 in. on center.

Two types of construction have been adopted for long spans:

1. The catenary type where a suspension guy relieves the messenger strand of the larger part of the load. The theory of the loaded catenary is not new but its application to the telephone plant is of recent development. Fig. 4 illustrates the catenary type.
2. Using high-strength steel messenger strand to carry the total weight of the cable. Fig. 5 illustrates an elongated simple span.

Economic considerations are the determining factor in deciding the length of span which can be justified in a given case. Catenary construction is used in our toll cable plant largely as a matter of convenience and as a means of carrying the cable suspension strand across streams or other barriers continuously without dead-ending. On the other hand a long span was built about a year ago, and more are projected, where the length of the span is in excess of 1000 ft. and in which the cable suspension strand alone carries the entire stress and no catenary construction is used. The latter are cable spans inserted in open wire lines at river crossings and the cable terminates on the crossing poles.

Advantages

Long span construction, under certain conditions, has distinct advantages, especially where there is an obstacle to clear, such as a river.

The simpler type of long span involving high-strength

Fig. 4—Long Span Employing Catenary Construction

Fig. 5—Typical Elongated Simple Span

messenger has several advantages over the catenary type. Theoretical considerations indicate that less bowing will occur in the simpler type of long span. Also, this type permits construction with somewhat smaller sags. As a matter of fact, with the same total number of steel strands used, slightly smaller sags could be obtained by hanging the strands and cable in one long span than if catenary construction were used. This is for the reason that the messenger strand will carry a greater proportion of the weight of the cable in the long span.

Conclusion

Eliminating service interruptions with their resultant inconvenience to subscribers, embarrassment to business, loss of revenue, etc., due to cable failures justifies far reaching measures.

It is felt that definite progress has been made towards building cable plant whose sheath continuity will be undisturbed except from extraneous or foreign influences. Further advances can probably be realized by pursuing the methods and developing the ideas presented.

Abridgment of

Iron Losses in Turbine Generators

BY C. M. LAFFOON*
Associate, A. I. E. E.

and

J. F. CALVERT*
Associate, A. I. E. E.

***Synopsis.**—In large turbine generators, there is no convenient method for determining the iron losses under load. It is the purpose of this paper to show, analytically, the factors influencing the change in iron loss with load; that on the basis of the flux distributions, the machines can be most conveniently divided into end zones, which present three dimensional problems, and a large central zone, which presents only two dimensional problems. The losses in each part are discussed qualitatively, and the losses in the central zone are obtained quantitatively for an ideal machine in which only the fundamentals of the flux waves are present. Contrary to the usual view, these losses do not vary as the square of the generated voltage, but are predominantly affected by the ratio of the slot to total leakage reactance. The results are given in curves. The complications in the problem introduced by the usual commercial designs by non-sinusoidal field forms, phase bands, etc., are discussed qualitatively.*

THE best conception of the factors producing iron loss in turbine generators can be obtained by investigating the flux distributions in the different parts of the magnetic circuit. The end zones will be discussed briefly and then the central zone in greater detail. Figs. 1, 2, and 3 indicate diagrammatically the direction of the flux in the plane passing through the center lines of the magnetic poles. There is a convenient division of the fields into end zones and a central zone. In the end zone it is necessary to consider the flux distribution as a three-dimensional problem whereas in the central zone it can be considered as a two-dimensional problem.

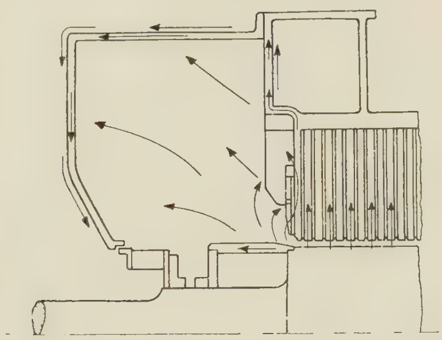

FIG. 1—FLUX DISTRIBUTION IN CENTER PLANE OF THE POLE-ROTOR EXCITED ALONE

It is necessary to decide between just what two radial planes two-dimensional conditions may be assumed. An estimate of this was made by assuming a simplified magnetic circuit as shown in Fig. 4. Fig. 5 has been drawn in an attempt to give a three-dimensional picture of these conditions. It is probably reasonable to assume that the end effects are confined to the first three packets on each end and that the large central zone presents only two-dimensional problems.

DISCUSSION OF THE STATOR IRON LOSSES

It is the large central part of the stator iron which will be discussed in this article. For calculation an ideal machine which has the following characteristics will be considered:

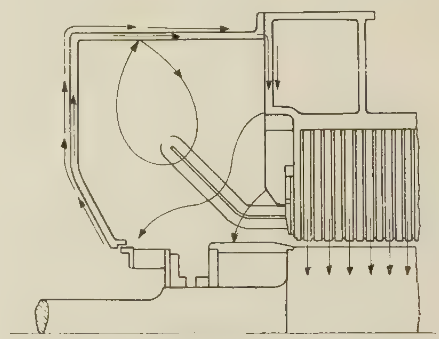

FIG. 2—FLUX DISTRIBUTION IN THE CENTER PLANE OF THE POLE, STATOR EXCITED ALONE

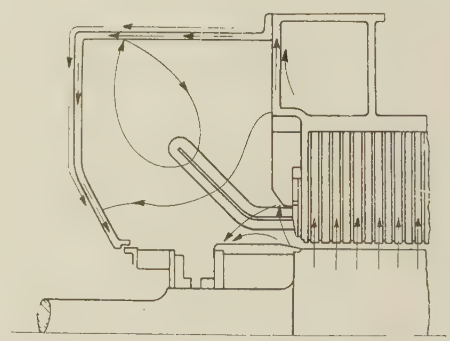

FIG. 3—FLUX DISTRIBUTION IN THE CENTER PLANE OF THE POLE, BOTH ROTOR AND STATOR WINDINGS EXCITED AT THE FULL-LOAD, ZERO POWER FACTOR, OVER-EXCITED CONDITION

1. A large number of teeth will be assumed, so that practically no tooth taper is present;
2. There will be as many phases as slots per pole so that the fundamental of the slot leakage flux may be considered alone; and
3. A full-pitch winding will be assumed.

In addition to the above assumptions for a special

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*Both of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

1. For references see Bibliography.

Presented at the Regional Meeting of the Middle Eastern District of the A. I. E. E., Cincinnati, Ohio, March 20-22, 1929. Complete copies upon request.

machine, the following general assumptions will be made:

4. The rate of eddy-current loss in watt-seconds per second per unit volume will be assumed proportional to the square of the instantaneous value of the resultant flux density in the laminated iron;

5. The hysteresis loss per cycle will be assumed proportional to the square of the maximum flux density for the conditions encountered in commercial machines; and

6. No allowance will be made for the redistribution

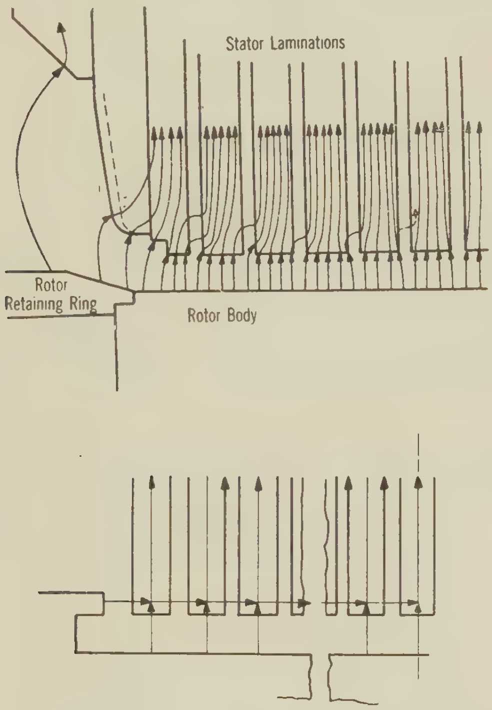

Fig. 4—Paths Assumed in Estimating the Axial Penetration of End Flux

of the flux in the main magnetic circuit due to changes in permeability between no-load normal voltage and full-load normal voltage conditions.

It is intended to consider the factors involved by the variations in the stator teeth and core loss on load as compared with the no-load conditions, due to the fundamental of the cross slot leakage flux and the increase or decrease in the air-gap flux. On all loads which require over excitation, the air-gap flux must be increased to produce a generated voltage equal to the vector sum of the terminal voltage and the armature leakage reactance voltage. Conversely, for practically all under-excited conditions, the air-gap flux is less at the load than at the no-load full-voltage condition.

The armature leakage reactance voltage is usually divided into two main parts,—the voltage due to the end winding flux, and the voltage due to the slot leakage flux. (In this machine there will be no "tooth tip leakage flux," because no higher harmonics have been assumed.) The end winding reactance flux influences the densities in the main magnetic circuit, because it usually necessitates a change in the air-gap flux to maintain constant terminal voltage. It has been explained, previously, that the effect of the end winding flux, as such, can be neglected when considering densities in the central part of the stator iron. The reactance

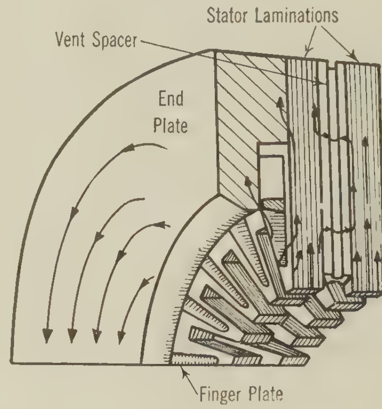

Fig. 5—Flux in the Stator End Parts

produced by the armature slot leakage flux also necessitates a change in the air-gap flux in order that constant terminal voltage shall be maintained. However, the paths of the latter flux (Fig. 8) are through the same stator iron parts as are occupied by the air-gap flux.

Loss in the Core

It is now possible to estimate the relative losses in the core back of the teeth on the basis of the foregoing

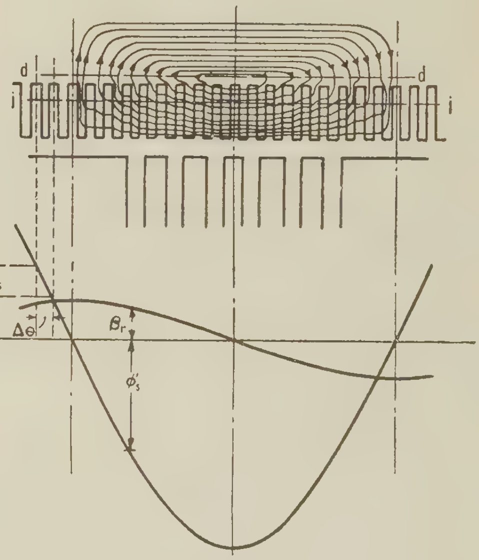

Fig. 8—Assumed Distribution of Armature Slot Leakage Flux

assumptions. Both the air-gap flux, ${}_1\Phi_a$, and the radial component of the slot leakage flux, $2\ \Phi_s$, have sinusoidal distributions at some circumferential line $d - d$, as shown in Figs. 8 and 9. These components of flux combine to give a resultant sinusoidal flux wave so that on the basis of assumptions 4, 5, and 6, it follows that the ratio of core loss on load to that on no load must be

$$\frac{{}_1W_c}{{}_0W_c} = \left\{ \frac{{}_1\Phi_a + \overline{2\,\dot{\Phi}_s}}{{}_0\Phi_a} \right\}^2 \tag{1}$$

In this case the vector quantity $\overline{2\,\dot{\Phi}_s}$, is in phase with the maximum radial density due to the cross slot flux.

Loss in the Teeth

The changes in tooth loss with load are much more difficult to describe than the core loss, but can be illustrated with drawings. The difficulty is that the air-gap and slot leakage flux distributions do not have the same general shape in the teeth, whereas they did have in the core. In the teeth, the armature windings establish both tangential and radial densities, while the air-gap field produces only radial densities. (See Figs. 8 and 9). Hence, the tangential density and the resultant radial density must be known at every point in the tooth throughout one cycle. Obviously, at every instant of time, the resultant density squared is equal to the sum of the squares of the tangential and the resultant radial densities.

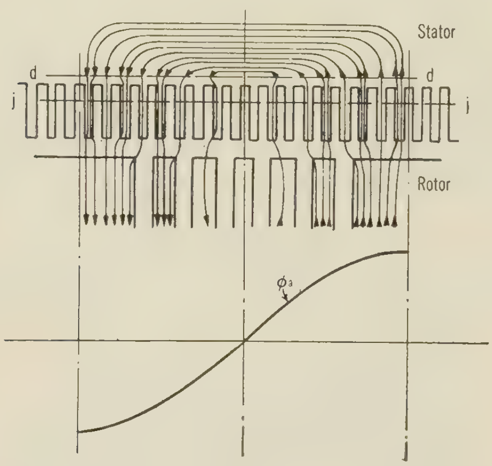

Fig. 9—Assumed Distribution of Air-Gap Flux

$$\beta_T^2 = \beta_R^2 + \beta_s^2 \tag{2}$$

The rate of eddy-current loss per unit volume per cycle is proportional to the mean square value of the resultant density, $\frac{1}{\pi}\int_{\theta=0}^{\theta=\pi} \beta_T^2\, d\,\theta$, but,

$$\frac{1}{\pi}\int_0^\pi \beta_T^2\, d\,\theta = \frac{1}{\pi}\int_0^\pi \beta_R^2\, d\,\theta + \frac{1}{\pi}\int_0^\pi \beta_s^2\, d\,\theta \tag{3}$$

Hence, the eddy-current loss due to the density components displaced 90 deg. in space may be computed separately and added.

The rate of hysteresis loss per cycle is proportional to the maximum density squared.

Figs. 30 and 31 give the total variations in iron loss with load as functions of power factor. Various ratios of slot to total reactance and two values of total per cent reactance are chosen as shown. Certain ratios for the loss on no-load were assumed, as follows:

$$\frac{\text{No-load core loss}}{\text{Total no-load iron loss in the machine}} = \frac{{}_0W_c}{{}_0W_T} = 0.6$$

$$\frac{\text{No-load eddy-current loss in the teeth}}{\text{Total no-load iron loss in the machine}} = \frac{{}_0W_{et}}{{}_0W_T} = 0.1$$

$$\frac{\text{No-load hysteresis loss in the teeth}}{\text{Total no-load iron loss in the machine}} = \frac{{}_0W_{ht}}{{}_0W_T} = 0.3$$

All curves apply to the large central zone in the stator and are for four-pole machines.

I. Ratio of the core loss on load to that on no-load.

$$\frac{{}_1W_c}{{}_0W_c} = 1 + 2\left(\frac{I\,X_t}{E_t}\right)\sin\gamma + \left(\frac{I\,X_t}{E_t}\right)^2 - 3\left(\frac{I\,X_s}{E_t}\right)\left(\frac{I\,X_t}{E_t} + \sin\gamma\right) + \frac{9}{4}\left(\frac{I\,X_s}{E_t}\right)^2. \tag{5}$$

(Note that $\cos\gamma$ = power factor.)

This includes both hysteresis and eddy-current loss.

II. Ratio of the eddy-current loss in the teeth on load to that on no-load.

$$\frac{{}_1W_{et}}{{}_0W_{et}} = 1 + 2\left(\frac{I\,X_t}{E_t}\right)\sin\gamma + \left(\frac{I\,X_t}{E_t}\right)^2 - 2\left(\frac{I\,X_s}{E_t}\right)\left(\frac{I\,X_t}{E_t} + \sin\gamma\right) + \left(\frac{I\,X_s}{E_t}\right)^2\left(\frac{3}{K_3^2} + \frac{6}{5}\right) \tag{6}$$

III. Ratio of the hysteresis loss in the teeth on load to that on no-load.

$$\frac{{}_1W_{ht}}{{}_0W_{ht}} = \frac{1}{2}\,\frac{{}_1W_{et}}{{}_0W_{et}} + \frac{1}{2}\int_{\frac{x}{l}=0}^{\frac{x}{l}=1} \sqrt{\begin{aligned}&\left\{\cos^2\gamma - \left(\frac{I\,X_t}{E_t} + \sin\gamma\right)^2 + 3\left(\frac{I\,X_s}{E_t}\right)\left(\frac{I\,X_t}{E_t} + \sin\gamma\right)\left(1 - \frac{x^2}{l^2}\right) - \frac{9}{4}\left(\frac{I\,X_s}{E_t}\right)^2\left[\left(1 - \frac{x^2}{l^2}\right)^2 - \frac{4}{K_3^2}\,\frac{x^2}{l^2}\right]\right\}^2 \\ &+ \left\{3\left(\frac{I\,X_s}{E_t}\right)\left(1 - \frac{x^2}{l^2}\right) - 2\left[\frac{I\,X_t}{E_t} + \sin\gamma\right]\right\}^2\cos^2\gamma\end{aligned}}\; d\left(\frac{x}{l}\right) \tag{7}$$

It should be remembered that certain design constants must be involved in the numerical constants of these equations. For instance, the ratio of the iron area for the cross slot flux to that for the radial flux must be introduced, and it depends upon the physical proportions of the machine. (See the list of symbols under Notation for the value k_3).

General Conclusions

In the central portion of the ideal generator (which has only fundamental flux waves), the ratios of iron loss

on load to those on no-load are not only functions of total reactance and power factor, but also of the ratio of slot to total reactance.

The actual loss in these parts is considerably less at operating conditions than is calculated by the usual method wherein the assumption is made that the iron loss varies as the square of the generated voltage. This is illustrated in Figs. 30 and 31. If a machine has a ratio of slot to total reactance of about 0.7, there is practically no variation in iron loss with load.

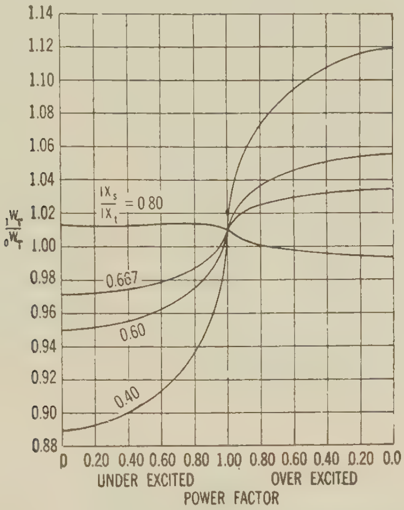

FIG. 30—RATIO OF FULL-LOAD STATOR IRON LOSS *vs.* POWER FACTOR FOR FOUR-POLE TURBINE GENERATOR WITH $\frac{I\,X_t}{E_t} = 0.12$

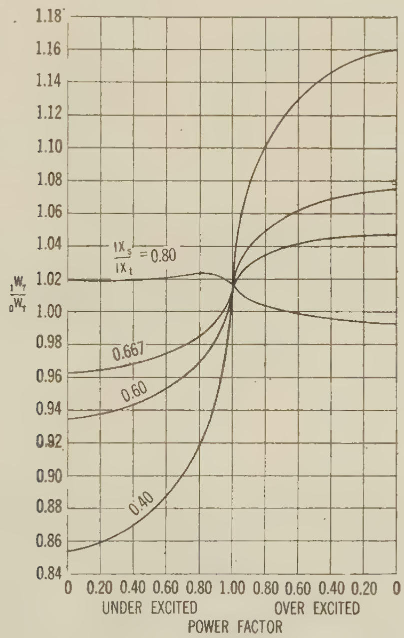

FIG. 31—RATIO OF FULL-LOAD TO NO-LOAD STATOR IRON LOSS *vs.* POWER FACTOR FOR FOUR-POLE TURBINE GENERATOR WITH $\frac{I\,X_t}{E_t} = 0.16$

where IX_s = slot leakage reactance
IX_t = total leakage reactance
E_t = terminal voltage

The quantitative analysis of the variations in iron loss for an actual commercial machine is vastly more complicated than for the ideal generator in the central portion of the stator, and some of the factors cannot be considered at all. These are discussed in the unabridged copy of the paper.

It is possible to make analytical calculations for the loss in certain of the end zone parts. For instance, if the flux distribution in the end-bell iron can be established, a two dimensional problem may be assumed within the metal. However, the effect of the axial flux in the stator fingers, end plates, and first two or three packets, probably, can be investigated properly only by tests which will permit the separation of the end zone from the central zone losses. Tests on machines of different lengths could be used if it could be established that the loss per inch axially in the central zone was substantially the same in each test; and not at variance due to building differences.

ACKNOWLEDGMENTS

The writers are indebted to Messrs. L. A. Kilgore, A. M. Harrison, and H. C. Myers of the Power Engineering Dept. for valuable theoretical assistance and for calculating data for the curves.

NOTATION

Flux Symbols

$_1\Phi_a$ = resultant air-gap flux per pole on load at normal voltage.

$_0\Phi_a$ = air-gap flux per pole on no-load at normal voltage.

Φ_s = maximum flux across any one slot due to the armature windings.

φ_s = instantaneous value of Φ_s.

φ_s' = instantaneous value of cross slot leakage flux between any circumferential line $j - j$ in the teeth and the teeth tips.

β_s = instantaneous tangential density at any point in a tooth due to the armature cross slot leakage flux.

β_R = instantaneous resultant radial density at any point in a tooth.

Voltage and Current Symbols

(All values are per phase)

E_t = terminal voltage.

$I\,X_t$ = total armature leakage reactance.

$I\,X_s$ = armature slot leakage reactance.

Loss Symbols

$_1W_c$ = total loss in the stator core on load.

$_0W_c$ = total loss in the stator core on no-load.

$_1W_{et}$ = eddy-current loss in the teeth on load.

$_0W_{et}$ = eddy-current loss in the teeth on no-load.

$_1W_{ht}$ = hysteresis loss in the teeth on load.

$_0W_{ht}$ = hysteresis loss in the teeth on no-load.

$_1W_T$, and $_0W_T$ = total iron loss in the machine on load and on no-load, respectively.

Angular Symbols

θ = angular displacement with respect to some one point on the stator. Counterclockwise rotation is assumed.

θ = $2\,\pi \times$ frequency $\times$ time)

γ = power-factor angle and is assumed positive when the current lags the terminal voltage.

Dimension Symbols and Constants

x = radial distance from the base of the slot toward the tooth tip.

l = total depth of slot.

D = diameter at stator tooth tips.

P = number of pairs of poles.

A_p = total area of cylindrical surface at the tips of the teeth.

A_i = total area of magnetic material in the cylindrical surface at the tips of the teeth.

K_2 = stacking factor.

K_3 = constant for a given machine.

$$\left(K_3 = \frac{A_p}{A_i}\;\frac{2\,P\,K_2\,l}{D}\right)$$

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Abridgment of

Cathode Ray Oscillograph Study

Of Artificial Lightning Surges on the Turners Falls Transmission Line

BY K. B. McEACHRON*
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and

V. E. GOODWIN*
Associate, A. I. E. E.

Synopsis.—*A portable impulse generator delivering 400 kv. has been constructed. A cathode ray oscillograph of the cold cathode type has been so connected that impulses incoming over the transmission line to which it is connected will initiate the oscillograph.*

The results of studies on a 5.77-mi. section of a 66-kv. line of the Turners Falls Power Company are given. Impulses of definite forms are applied to the line. The theory of traveling waves is being checked experimentally, demonstrating the existence and magnitude of reflections, both for open-ended lines and for lines closed through gaps or a combination of inductance and capacity. A simple description of the theory is given.

Some preliminary results are given for attenuation obtained by successive reflections from either end of the line.

The reduction of the incoming waves by an oxide film lightning arrester is given, the affected wave in one case having a front of six microseconds and in another case a front of 0.5 microseconds.

Further work to be done includes the effect of traveling waves on choke coils, transformers and ground wires. Additional work is to be done to determine the laws governing attenuation.

* * * * *

THE equipment required consists essentially of cathode ray oscillograph equipment which can be set up and operated in the field, and an impulse generator which is easily moved along the transmission line as desired.

The oscillograph[1] is the cold cathode type[2] which is not suited to continuous operation unless the cathode potential is kept low, which interferes with its ability to record high-speed transients, photographically. Therefore one of the first requirements in the use of this oscillograph for transient registration is that means must be provided for exciting cathode at the time of the occurrence of the transient.

When endeavoring to record lightning surges on a transmission circuit, it is necessary that the incoming transient set off a trip circuit which will excite the cathode and complete necessary connections so that the oscillograph is in operation within, perhaps, a millionth of a second after the voltage at the oscillograph begins to rise due to the incoming transient.

With a study such as that being described in this paper, it is desired to obtain oscillograms of natural lightning transients as well as records of the man-made lightning transients; the circuits therefore are arranged to be operated either way.

In Fig. 1 the cathode ray oscillograph circuit shown at the right is initiated at the same time that a small impulse is sent out by the oscillograph operator on the lower conductor of the transmission line. This impulse reaches the impulse generator shown at the left and causes the three electrode gap to spark over. Since

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1. For all references see Bibliography.

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the impulse generator is kept charged, the generator circuit will be tripped by the operation of the three electrode gap, and the discharge of the impulse generator takes place, sending out an impulse on the middle wire of the transmission line.

This impulse reaches the cathode ray oscillograph whose cathode stream has already been established

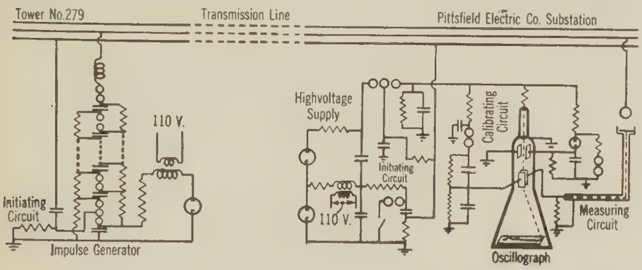

FIG. 2—CIRCUIT FOR APPLYING TRANSIENTS TO A TRANSMISSION LINE

Arranged to pre-excite the oscillograph so that the entire wave-front may be obtained

and the change in potential at the deflecting plates of the oscillograph is recorded as in Fig. 7.

In case the oscillograph is to be operated by a transient due to lightning, the initiating circuit is modified, the three-electrode gap at the oscillograph being connected to the transmission line through a capacitance potentiometer. When the transient itself initiates the oscillograph, because of the time delay in getting the oscillograph under way the initial portion of the incoming transient is lost. (Such an oscillogram is given in Fig. 10 of the complete paper.)

THE TRANSMISSION LINE

The transmission line on which these tests are being made consists of a double circuit, and extends from the Pittsfield Silver Lake Substation to the Cabot Station of the Turners Falls Power Company on the Connecticut River. The total length of circuit is 36.7 mi., passing over rather hilly country in western Massachusetts.

The line was built for 110-kv. operation, but is now operating at 66 kv. The average height of line at the tower is 71 ft. for the top conductor. At points (five) along the line, disconnecting switches have been provided. Tests have been made only at Tower 279 which is located a distance of 5.77 mi. from the Silver Lake Substation.

IMPULSE GENERATOR

The impulse generator is designed to deliver a crest potential to ground of 400 kv. Sixteen oil capacitor units are charged in parallel and discharged in series making use of the Marx[3] circuit as indicated in Fig. 1. The generator has a capacity of 0.0156 μ f., the stored energy being 1250 watt-seconds.

Tests have been made with two wave fronts, one a fast wave reaching its crest in about ½ microsecond, and the other, a slower wave rising to its crest in about 6 microseconds.

Fig. 5 shows the impulse generator at the base of Tower 279 with the connections made, and the disconnects open. The illustration shows the line extending over the hills to Pittsfield and gives a fair idea of the type of country traversed by this line. The cathode ray oscillograph is located at the Silver Lake Substation.

LINE CHARACTERISTICS

In order that a proper understanding of the principles involved may be obtained by the reader, two oscillograms are given in Fig. 7 which will be discussed in some detail. The circuit diagram is given under each oscillogram. It should be noted in both cases that the impulse generator and the cathode ray oscillograph are both at the Pittsfield end of the line. Also in both cases the disconnects are open at Tower 279, 5.77 mi. away. In the upper oscillogram there is no apparatus connected at tower 279, while in the lower oscillogram a sphere-gap which arced over is connected between line and ground.

The oscillograms are alike and may be superimposed up to the point where the gap sparked over. These

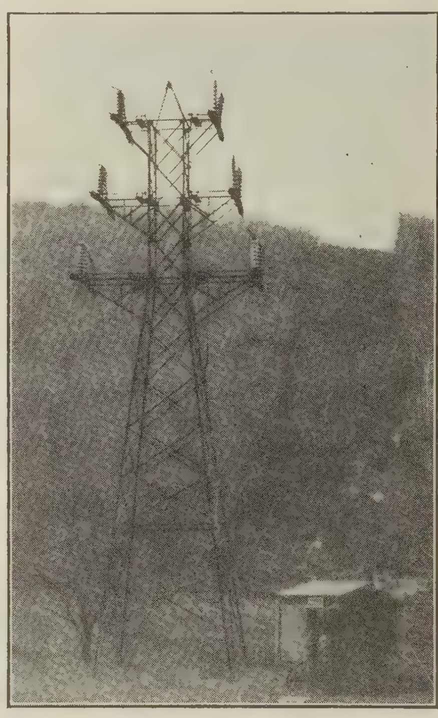

FIG. 5—TOWER 279—SHOWING PORTABLE IMPULSE GENERATOR

Line in foreground extends to Pittsfield

oscillograms show the initiation of the oscillograph by the transient itself, which is the reason for the missing portion of the front of the wave.

TRAVELING WAVES

A proper understanding of the oscillograms in Fig. 7 requires some knowledge of how such waves travel on transmission lines.

A wave travels along a line by charging up the capacity of the line as the voltage is increasing on the front of the wave, and discharging the line capacity as the voltage decreases on the tail of the wave. Such a process requires that the wave form of current exactly correspond to the wave front of voltage.

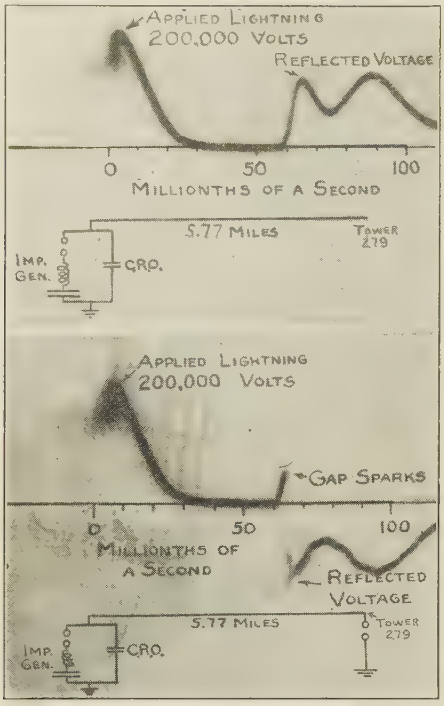

Fig. 7—Oscillograms Showing Initial and Reflected Waves with Impulse Generator and Oscillograph Both at Silver Lake Substation

Upper oscillogram open ended line at Tower 279
Lower oscillogram line closed through gap at Tower 279

When such a wave is traveling along a line, two equal energies need be considered; one is electromagnetic and is stored in the magnetic field around the conductor due to the transient current, and the other energy is electrostatic and is stored in the electrostatic field between the conductor and ground. If the wave meets with an open circuit at the end of a line, all of the energy at the open end becomes electrostatic, and the potential at the end of the line is doubled. Neglecting losses, the reflected wave will be identical with the original wave.

If the traveling wave meets a short circuit to ground, the electrostatic energy at the short circuit becomes zero and the electromagnetic energy is doubled, as is also the current in the short circuit. If the crest current of the traveling wave is I amperes, (which value is obtained by dividing the crest potential of the traveling wave by the surge impedance of the line), then the current in the short circuit will be two I amperes.

When a resistance equal to the surge impedance is connected between line and ground, the energy of the traveling wave is absorbed in the resistance with no reflection either of voltage or current.

An electrostatic capacity connected between line and ground acts first like a short circuit, and as it becomes charged, acts more and more like an open circuit. An inductance acts in the opposite manner, acting first like an open circuit and later as a short circuit. Thus when a traveling wave meets an inductance connected between line and ground, the potential rises, followed by a reversal of polarity as the inductance begins to act as a short circuit.

The effect of the circuit conditions used in taking the upper and lower oscillograms in Fig. 7 is shown in Figs. 9A and 9B. An impulse is seen traveling away from the impulse generator toward the open ended line. (Wave No. 1).

An oscillograph at the end of the line would have shown a volt—time curve such as that shown A (2) at

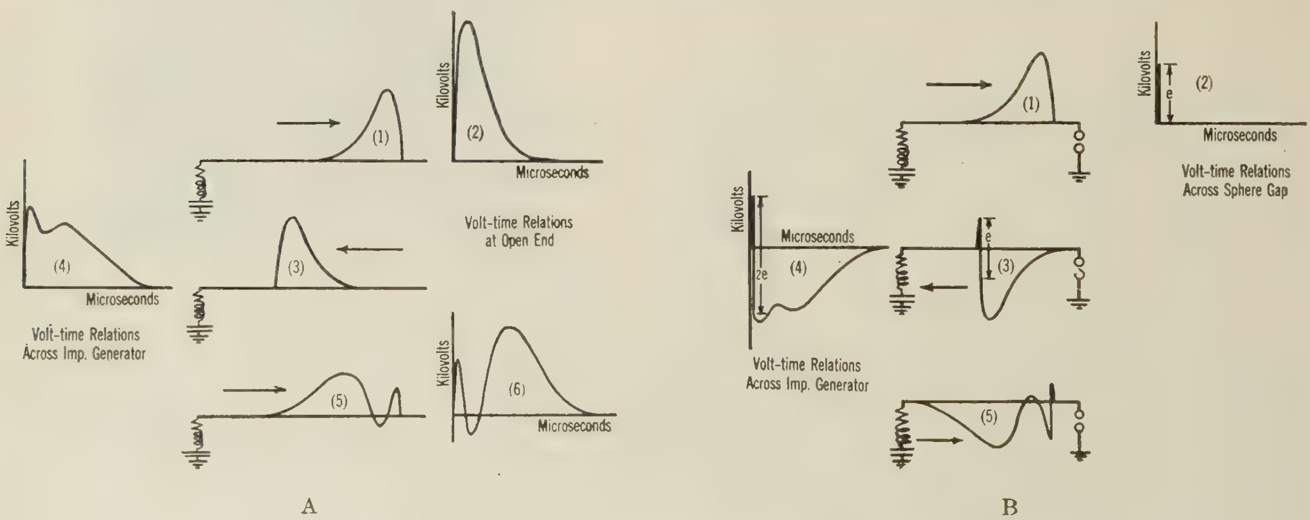

Fig. 9—Reflections with Impulse Generator at One End of Line

a. With open-ended line
b. Line closed through a gap set for e volts

the right. The reflected wave (3) is traveling back toward the impulse generator. With the line being considered, the reflected wave returns to the impulse generator in about 62 microseconds. In this short space of time the tests have shown that the gaps at the impulse generator are still ionized so that the impulse generator may be considered as inductance and capacity and resistance at the end of the line. The

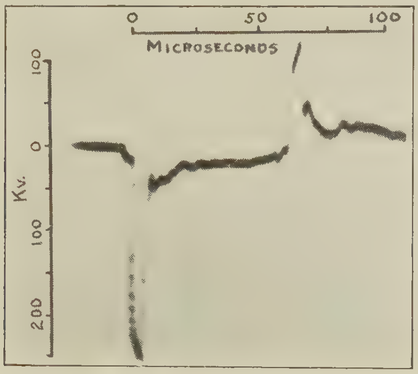

FIG. 11—CHOPPED WAVE-GAP SET AT 197-KV. CREST

voltage-to-ground across the impulse generator with respect to time is shown at the left (4), and corresponds to the reflection shown in the respective oscillograms of Fig. 7. This curve is the sum of the reflected wave (5) from the impulse generator and the reflected wave from the open end (3).

The wave (5) reflected from the impulse generator travels to the open end of the line where a reflection takes place as shown by (6).

In Fig. 9 an attempt has been made to set up con-

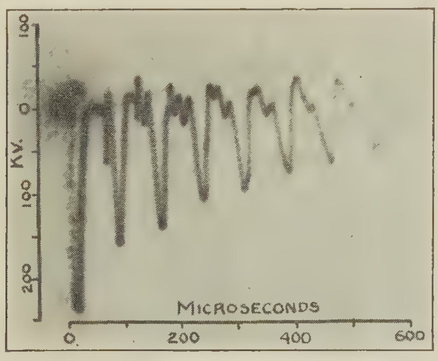

FIG. 12—SUCCESSIVE REFLECTIONS, FULL WAVE

ditions which would check approximately the oscillograms and also in such a manner as to be able to visualize how the reflections take place and show that inductance and capacity will give a form of wave similar to those observed. Mr. O. Brune has calculated these reflected waves by the methods of the operational calculus and his methods are outlined in a forthcoming article in the *General Electric Review*. He has been able to find quite satisfactory agreement with the oscillograms.

CHOPPED WAVES

Since in practise traveling waves are frequently cut off by flashover of insulators it is worth while to consider the effects of the line constants and apparatus on such waves.

The dotted curve in Fig. 16 shows a so-called full wave which rises to its crest in 6 to 8 microseconds, as determined by the use of a high-frequency oscillator which makes it possible to measure the front accurately. Since the impulse generator is at the far end of the line, the oscillogram shows the voltage rise at the station end of the line and thus is probably close to double the voltage of the traveling wave.

In Fig. 11 all conditions were unchanged except that a sphere-gap was connected between line and ground at the impulse generator and set to spark at about the crest of the wave. It is interesting to note how steep the cut-off is and that the reflection comes back reversed to the station end where the oscillograph is located,

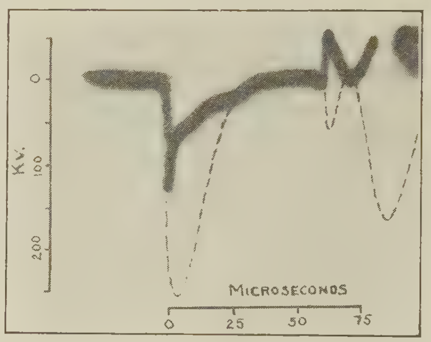

FIG. 7—ARRESTER PERFORMANCE CHARACTERISTICS ON 6-MICROSECOND FRONT

Dotted curve—impulse at oscillograph without arrester. (See Fig. 10)
Oscillogram—taken across 85 *O F* cells

which shows that the gap is still ionized. The sloping of the wave due to corona can be seen on the front of the reflected wave. When studying these oscillograms it should always be remembered that they represent voltage changes at the oscillograph with respect to time. From them, with proper interpretation, the traveling wave can be deduced.

ATTENUATION

The attenuation on lines is a matter of considerable importance in the protection of lines and station apparatus. It seems to have been quite definitely shown[4] that for dangerous voltages the attenuation depends largely at least on the effect of corona.

Some preliminary results are available on the short section of line worked with up to the present time.

The method of making these tests was to apply at tower 279 an impulse which reflected back and forth over the line which except for the small capacity of the oscillographic equipment and the station bus capacity was open at the oscillograph and closed to ground throught he impulse generator at tower 279. The

first two reflections measured by the oscillograph are shown by the dotted curve in Fig. 16. The oscillogram in Fig. 12 shows eight of these reflections, which corresponds to a length of line of approximately 85 mi.

Surge Impedance

Some preliminary work has been done in an effort to determine the surge impedance of the line. When the line is closed through resistance equal to the surge impedance no reflection will take place. By taking oscillograms of the voltage across the resistance, its value can be adjusted until the reflection disappears.

This method of determining the impedance does not give a very accurate result, but the oscillograms taken show that the surge impedance lies between 320 and 530 ohms. The calculated value of just the middle wire alone and one ground wire is 500 ohms. The effect of the other conductors is to lower the calculated value. The surge impedance may also be lowered by corona, and it is hoped that data will be securable which will determine this point.

With this line, it will be possible to determine the effect of stopping the ground wire some distance from the station and also the effect of additional ground wires near the station. The magnitude of voltages and currents will be studied with their relation to ground resistance of the tower footing. Thus it is expected that definite information regarding the benefit derived from additional ground wires from the standpoint of the effect on the surge impedance will become available.

Apparatus Characteristics

The effect on the incoming impulse of choke coils, lightning arresters, bushings and transformers, outgoing circuits, and the effect of station bus work is to be studied. The work with regard to all other apparatus except the lightning arrester is in too preliminary a state to give any results in this paper. Some very interesting results on an oxide film arrester are available.

Oxide Film Arrester

Since voltages comparable with the maximum allowed by the line insulation of six disks were not available, it was decided to reduce the size of the arrester to be tested to such a magnitude that it would have a potential applied comparable with what it might get in service.

The oscillogram taken across the arrester is shown in Fig. 16 together with the wave without the arrester, as shown by the dotted line. The potential has been reduced by the arrester and its duration has been greatly decreased. The arrester has changed a wave of dangerous potential and comparatively long duration into one of much shorter duration with a crest voltage safely below the strength of the parallel insulation.

Summary

1. Theory of traveling waves is being checked experimentally, demonstrating the existence and magnitude of reflections, both for open-ended lines and for lines closed through gaps or combinations of inductance and capacity. A simple discussion of the theory is given.

2. The effect on incoming waves of various pieces of apparatus, such as lightning arresters, choke coils, transformer bushings and the effect of busses or other transmission lines connected to the bus is being studied.

3. The effect of ground wires on attenuation is being investigated which includes the influence of additional wires near the station as well as the effect of stopping the ground wire several towers out from a station.

Acknowledgments

The authors wish to express to Mr. F. L. Hunt and others of the Turners Falls Power Company, and also to Mr. Granville Whittlesey of the Pittsfield Electric Company, their appreciation of the cooperation given in the investigation, and without which the work could not have been done.

The work of the investigation has been carried on by Messrs. E. J. Wade, W. J. Rudge, Jr., O. Brune and T. Brownlee. These men have all contributed largely in the design and construction on the impulse generator and the successful design of the oscillograph circuits, and the operation of the equipment.

The authors express to these men their appreciation for the service they have rendered both in connection with the investigation and the writing of this paper.

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ENGINEERING SOCIETIES EMPLOYMENT SERVICE

EXCERPTS FROM LETTERS OF APPRECIATION

December 30, 1928.

I am convinced that your method is a good one, even though I did not profit by it, and I will be glad to recommend it in the future to my friends.

I appreciated your kind and sympathetic handling of my case and will be glad to cooperate with you in the future, when I am in need of men.

November 7, 1928.

I am satisfied with my present conditions so would not be interested in following up the job in question.

November 7, 1928.

I was very much pleased with your Service and believe it well worth while, and want to thank you for the many courtesies shown me. Should I ever have reason to require or desire a change, I will get in touch with you.

Abridgment of

Lighting of Airways and Airports

BY H. E. MAHAN[1]
Associate, A. I. E. E.

Synopsis.—*The Department of Commerce under the Air Commerce Act is responsible for the installation, operation, and maintenance of the national airways. The lighting facilities along the airways consist of revolving beacons at 10-mi. intervals and intermediate landing fields approximately every 30 mi. The intermediate landing fields, in addition to the revolving beacon, are provided with an illuminated wind cone, boundary, approach, and obstruction lights. The Department of Commerce is also responsible for the rating of airports, although their establishment, maintenance, and operation are matters of municipal or private concern. The rating of an airport is a measure of the facilities available. A preferred rating for lighting facilities requires the installation of an airport beacon to locate the airport from distant points, an illuminated wind direction indicator, white or yellow lights marking the boundary of the landing area, red lights on all obstructions, green range lights marking approaches, floodlighted hangars or other buildings as a measure of altitude and to illuminate identifying markings, a searchlight for measuring ceiling height, and suitable floodlighting for the landing area.*

In view of the regulating authority vested in the Department of Commerce, the practise in lighting airways and airports follows very closely established standards. The floodlighting of the landing area proper offers the greatest opportunity for original thought and ideas. There have developed two schools of opinion regarding the fundamentals of field floodlighting systems. One school favors the use of a single unit, or a group of units, at one location for floodlighting the field, which system is referred to as the centralized system. The opposing school, advocating two or more light sources placed at different locations about the field, is known as the distributed system. Both systems have in common the use of lighting units delivering a fan shaped beam of light only a few degrees wide in the vertical plane and varying from 45 deg. to 180 deg. in the horizontal plane.

The present lighting facilities are found very satisfactory during fair weather but the problem of aiding the flier during fog still faces the engineer and research scientist as a problem.

* * * * *

LAST year was celebrated the 25th anniversary of the first airplane flight of the Wright Brothers at Kitty Hawk, N. C. To-day, the Department of Commerce reports that there are 15,128 mi. of airways operating, and 1330 established airports in the country exclusive of Army and Navy fields. Of this number, 9341 mi. of airways, 274 intermediate fields and 74 other types of fields are lighted for night flying. By July 1, 1929 it is expected to have 11,270 mi. of lighted airways. This is truly a remarkable record of progress and a glance at the map (Fig. 1) indicates the present scope of organized air transportation.

Obviously, if such facilities are to be operated at the maximum of efficiency, the service must be continued throughout the twenty-four hours of the day, for it is the distance covered between the end of one business day and the beginning of the next one that gives air travel its greatest advantage over other forms of transportation. In other words, the movement of material and passengers during the night conserves daylight working hours, and the greater the distance that may be covered in this period, the greater the benefit realized.

Thus arises the problem of providing adequate lighting that will permit after-dark operations at our airports and along our airways. The author advances no original ideas for the solution of this problem, but merely outlines the practise followed at the present time in lighting and marking airports and airways for night flying.

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Presented at the Regional Meeting of the Middle Eastern District of the A. I. E. E., Cincinnati, Ohio, March 20-22, 1929. Complete copies upon request.

Airways

An airway is defined by the Department of Commerce as "An air route between air traffic centers with landing facilities at intervals equipped with aids to air navigation and communication system for transmission of

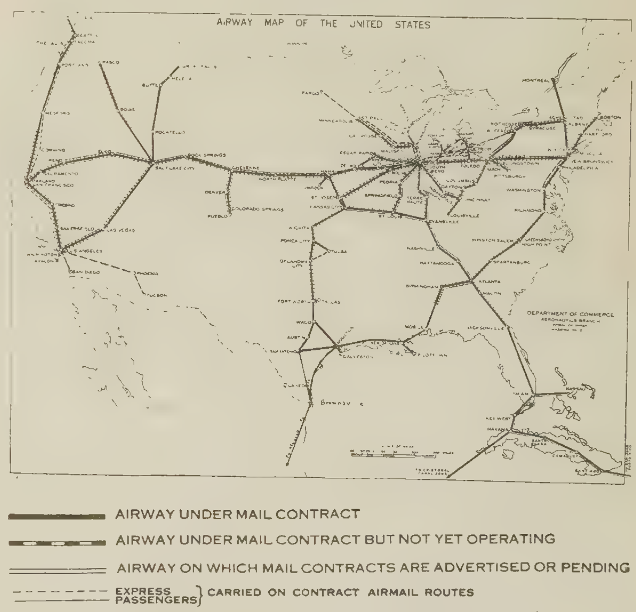

Fig. 1—Airway Map of the United States Showing Routes Lighted and to be Lighted

information pertaining to the operation of aircraft. The term 'airway' may apply to an air route for either land planes or sea planes, or both." Under the Air Commerce Act of 1926, the Secretary of Commerce has authority to establish and maintain civil airways

operate and maintain intermediate landing fields, lights, signal and radio direction finding apparatus and other structures and facilities (excepting airports) used as aids to navigation. In fulfillment of this obligation, the Department of Commerce has established along the airways, beacon lights at 10-mi. intervals and emergency landing fields at 30-mi. intervals.

The beacon (Fig. 3) consists of a 24-in. revolving incandescent searchlight equipped with a 1000-watt, 115-volt lamp and mounted on a steel tower. Automatic lamp changers are provided to replace a burned-out lamp with a new one held in reserve. The beacon is supplemented by two "course" lights consisting of 500-watt projectors, one facing in each direction along the airways. The course lights are flashed by a mechanism integral with the beacon mechanism and synchronized to flash the course light opposite to the position of the beacon along the airway. The flashes indicate in code the number of the beacon, and thus, to the pilot, his position along the airway. These course lights are equipped with red lenses where no landing field is available and a yellow lens where there is an intermediate field. Intermediate fields are equipped with a beacon, illuminated wind cone, boundary, approach and obstruction lights.

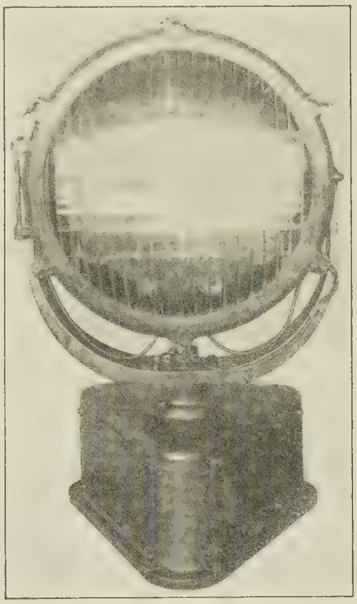

Fig. 3—Airport Beacon Conforming to Department of Commerce Specifications

Airports

The Department of Commerce requires that an airport in order to obtain the highest (A) rating for its lighting facilities, must have the following equipment:

a. An airport beacon
b. An illuminated wind-direction indicator
c. Boundary lights
d. Obstruction lights
e. Hangar floodlights
f. A ceiling projector
g. Landing area floodlighting system

Items (a) to (d) inclusive must operate all night.

The function of the beacon is to mark the airport from distant points. In order to accomplish this purpose effectively, a light must be sufficiently distinctive to contrast with surrounding lights; it must have a distribution which makes it visible at all points on the horizon and nearly to the zenith, and be of sufficient beam candle-power to carry great distances.

In order to carry out the policy of indicating the landing conditions at beacons along the National Airway System, it is recommended by the Department of Commerce that a green flashing auxiliary beacon be placed above the principal beacon to indicate that there is an airport at that location.

It is very essential that the pilot wishing to land be apprised of wind conditions on the field. The wind cone is perhaps the most generally used device for giving this information as it not only indicates the direction of the wind but also an approximate idea of its velocity. A method of lighting a wind cone (Fig. 4) consists of four 100-watt lamps in deep bowl porcelain enamel steel reflectors, grouped at right angles to each other on 2-ft. arms approximately 6 ft. above the wind cone. An obstruction light is placed on the top of the assembly. Another type of wind indicator (Fig. 5) is known as a wind tee and consists of a structure simulating an airplane and pivoted to change position with change of wind direction. It is illuminated at night by means of lamps placed on top of the

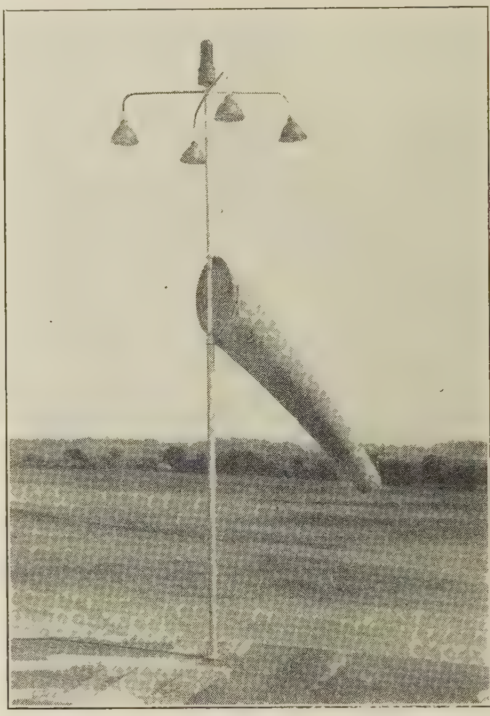

Fig. 4—Wind Cone Mounted on Roof of Hangar Showing Method of Lighting

tee and "reflectored" so as to throw the light on the structure and shield the direct light from the eyes of the pilot.

The extent of the field is made known to the pilot by means of light sources placed around the border of the landing area on approximately 300-ft. centers. A type of unit used for this service (Fig. 6) consists of a weatherproof housing and etched clear globe enclosing a 600-lumen (60-c.p.) 6.6-ampere series lamp or a 25-watt multiple lamp.

Fig. 5—Wind Tee

A wind direction indicating device illuminated by means of reflectored lamps on top of tee

A green globe is substituted for the clear, etched globe used on boundary fittings to serve as range lights for runways, or as markers for the most advantageous landing directions. Obstructions on or in the vicinity of the airport are marked with red lights placed at the highest, point of the structure. It is also the practise at some airports to make obstructions visible to the pilot by floodlighting them. This is found particularly advisable in connection with the hangars for in addition to making the buildings visible, it makes evident their height, and in this way gives the pilot a measure of hi- altitude. Such a system of lighting also provides illumination at the aprons of the hangar for the movement of planes and illuminates any signs or markings on the roof of the hangar. The illumination intensity recommended for hangar exteriors by the Department of Commerce is 2.5 foot-candles.

Fig. 6—A Form of Boundary Light Equipped with 600-Lumen 6.6-Ampere Series Incandescent Lamp

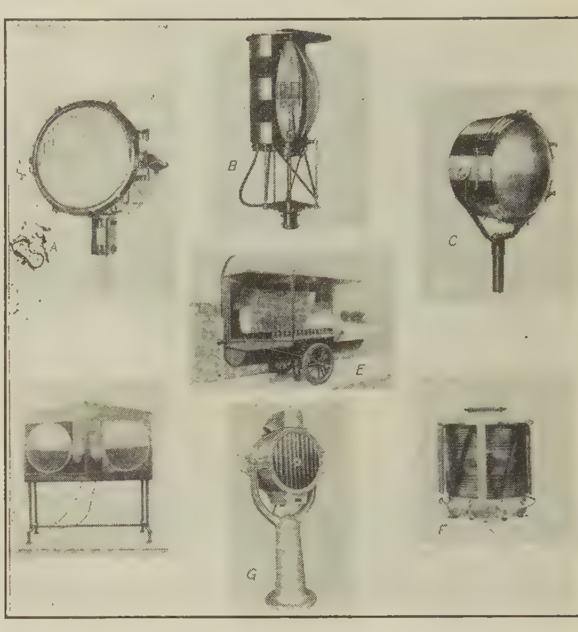

Fig. 9—Typical Forms of Airport Floodlighting Equipment

A. Incandescent Airport Floodlight. A 24 in. projector with chromium plated reflector and 45 deg. spread lens designed for use with 1500 watt and 3000-watt, 32 volt incandescent lamps.

B. Incandescent Airport Floodlight. Unit equipped with glass reflector designed to deliver a 180 deg. spread of light in the horizontal and limit the vertical spread to a few degrees. Lamp used may be either the 5-kw., 110 volt or 3000 watt, 32-volt incandescent lamp

C. Incandescent Airport Floodlight. Unit equipped with 25-in. mirrored glass reflector and spread convex heat-resisting lens of approximately 40 deg., 50 deg. or 80 deg. horizontal spread. Unit takes either the 1500 watt, 32 volt or 3000 watt, 32 volt incandescent lamp

D. Incandescent Airport Floodlight. Unit equipped with two 5-kw. or 10-kw. incandescent lamps, each in focus of 24 in. parabolic reflector. Beam spread in horizontal plane to about 80 deg. by diverging roundels.

E. Incandescent Airport Floodlight. Unit equipped with 14-3000-watt 32-volt incandescent lamps in the focal axis of a parabolic trough reflector The horizontal spread is 180 deg.

F. Airport Arc Floodlight. Unit equipped with a 150-ampere high intensity arc mechanism in the focus of a 21 element Fresnel lens. The horizontal spread is 180 deg. The 5-kw. or 10-kw. incandescent lamp may also be used with this unit.

G. Airport Arc Floodlight. Unit equipped with an 18-in. glass parabolic mirror and two front door glasses, one with clear glass and the other with 80 deg. spread lens. The spread lens may be swung back and the unit used as a high powered ceiling projector or as an auxiliary beacon. The lamp mechanism is automatic, operating at 55 amperes on a line voltage from 80 to 125 volts direct current

A beam of light has been found useful in determining the height of ceiling. The beam is directed on the clouds at a fixed angle and by sighting at the spot on the clouds from another point the height of ceiling is determined by triangulation.

Whereas the lighting facilities previously referred to follow rather definite regulations established by the Department of Commerce, a wider range of choice is

left to the engineer in selecting a system for the actual illumination of the field. The Department of Commerce requires for a field entitled to an "A" rating a minimum vertical illumination of not less than 0.15 foot-candles over the usable part of the field This is the illumination measured on a plane at right angles to the field surface and is a measure of the value of illumination incident upon the vertical sides of obstacles, grass, etc., facing the source of light. The light sources must be located so as to cause the least amount of glare in the eyes of the pilot for excessive glare is a potential cause of accidents. Needless to say, simplicity in operation and maintenance, together with reliability, are essential characteristics of the light sources. The system employing light sources close to the ground has met with general favor and may be divided into two divisions; *viz.*, the centralized system and the distributed system. In the former system a single large light source or a group of smaller light sources concentrated at one point is employed for obtaining the field illumination; in the latter, a number of relatively smaller units placed at two or more locations around the landing area are employed. The equipment (Fig. 9) used for field illumination employs both arc and incandescent light sources and a variety of optical systems for obtaining a fan distribution of light. In all cases, the vertical spread of the beam is restricted to a few degrees and the horizontal spread expanded to 45 deg. to 180 deg.

It is interesting to note a trend toward the study of the character of the field surface with respect to night illumination. Obviously, the higher the coefficient of reflection of the surface, the greater the amount of light reaching the observer's eye. Just as our highway executives have found it desirable to mark road boundaries and obstacles with white paint to make them conspicuous at night, so our airport engineers and managers will find the judicious use of light surfaces and white paint will greatly assist in the discrimination of essential objectives at night.

Abridgment of

The Fabrication of Large Rotating Machinery

BY H. V. PUTMAN[1]

Associate, A. I. E. E.

Synopsis.—*This paper is not intended as a general treatment of the above subject. It presents some of the more interesting experiences of the company with which the author is connected, in changing its designs of rotating machinery to employ fabricated steel in place of castings.*

* * * * *

WHAT are the advantages of fabricated steel that have led to its adoption in place of castings by some of the largest electrical manufacturing companies? It is not entirely a matter of cost, for while fabricated structures are usually cheaper, many show but little saving, and small structures of high activity are actually cheaper cast.

Even at the same cost, however, the use of fabricated steel may be justified for the following reasons:

1. The possibilities of future cost reduction are greater because the fabrication of steel is a comparatively new art, while the cost reduction possibilities of the cast construction have been largely exploited through many years of manufacturing experience and development.

2. The elimination of patterns is a clear gain. This is of greatest value in large special machines where only a single unit is made. It applies also to large bedplates where there are few exact duplicates and where, with castings, continual pattern changing was necessary.

3. The fabricated steel design is flexible. A large number of different structures can be made from a limited number of parts by welding them together in different combinations. Minor changes are easily made; greater strength may be obtained when required by additional structural members.

4. Shorter deliveries are possible because, with the foundry and pattern problem eliminated, the whole manufacturing process can be done in one shop, thus permitting greater concentration of responsibility in the manufacturing organization, a most important factor contributing to short deliveries.

5. The saving in weight is a valuable feature—especially in turbine generators and in all machinery used on shipboard. Some of the largest turbine generators can now be shipped with armature coils and laminations completely assembled. This not only eliminates the necessity of assembling coils and laminations in the customer's plant, but makes it possible to test these large machines for losses before shipment.

6. Fabricated steel structures are often better than those which were cast. There are many sales

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Presented at the Regional Meeting of the Middle Eastern District of the A. I. E. E., March 20-22, 1929. Complete copies upon request.

arguments in their favor and they are being demanded more and more by the trade.

Most of these points were listed in the beginning as economic advantages of fabricated steel before the decision to adopt it was made. Already the truth of

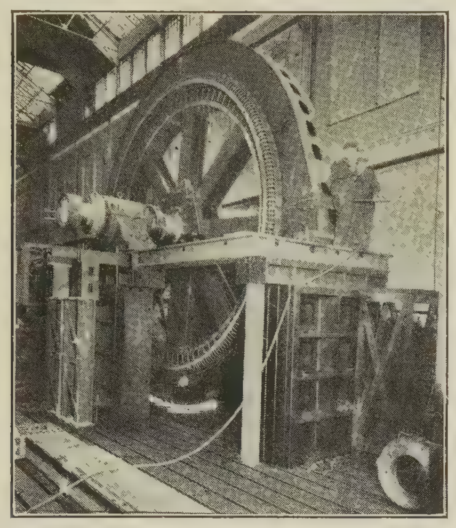


Fig. 1—5000-Hp., 82-Rev. Per Min. Synchronous Motor for Steel Mill Drive Assembled for Test

these statements is being demonstrated. New machines, comparable with the best machine tools, are being built to facilitate the practical application of the arc welding and gas cutting arts to quantity production.

The possibility of short deliveries was recently demonstrated in connection with an order for two

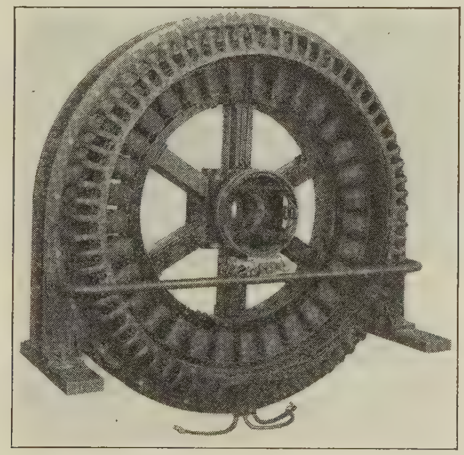


Fig. 2—Typical Low-Speed Synchronous Motor Stator with Fabricated Rotor in Place

5000-hp., 82-rev. per min. horizontal synchronous motors for steel mill drive, the first of which was delivered in ninety days and the second ten days later.

Fig. 1 shows a picture of the first machine, just 82 days after receipt of customer's order, when it was turned over to the Test Department for complete engineering tests. These motors are among the largest in physical dimensions ever built for an industrial drive. The fabricated steel construction, together with a completely equipped fabrication shop, made this extremely short delivery possible.

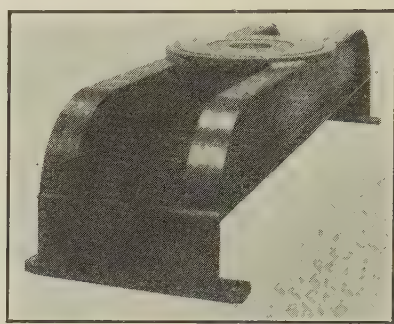


Fig. 5—Typical Fabricated Upper Bracket for Vertical Waterwheel Generators

Some of the special problems encountered by the Engineering Department in redesigning the various lines of rotating machines are of interest. One problem was to get designers to think clearly and with an open and unpredjudiced mind about the fundamental design problems of fabricated steel. Incidentally, much new thinking was done about the old designs in cast iron, and it was discovered that cast structures were designed as they were—not because of the requirements of the structure or the machine, but because of the requirements of foundry practise or the machine tools. Such a conclusion seemed so obvious as to be almost axiomatic, but a consideration of it helped to establish a new basis of thinking for the new design work in fabricated steel.

It was determined that all knowledge of cast design

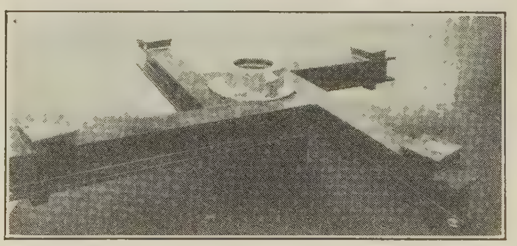


Fig. 6—Typical Lower Bracket for Vertical Water-Wheel Generator

should be put aside and even the appearance forgotten in an effort to make new designs with open, unbiased minds. The requirements of each machine or structure were determined; then a study made of the structural materials, plates, bars and beams, to see how these materials could be best employed to meet these requirements.

There had to be a definite reason for each step taken in the design work. As a result, the new designs were found to be radically different from previous cast structures and usually, much simpler in construction. Any savings were found to depend on the simplicity of the design and its general suitability to the use of structural materials.

The design of the different lines of fabricated machines is now completed and it is interesting to see how this point of view has been followed out in different lines.

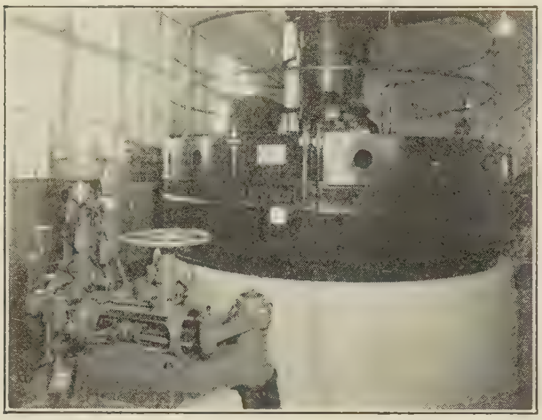


Fig. 7—Typical Vertical Waterwheel Generator, 625-Kv-a., 2400-Volt, Three-Phase, 60-Cycle 200-Rev. Per Min.

The frame construction of the smaller synchronous motors and generators having the core stacked on bolts between two frame rings gas cut from steel plate and left open in the back is now well known. It is a radical departure from the old cast frames in appearance but it is adapted to the use of structural materials and it fulfills all the requirements of the electrical machine even better than did the cast construction. Fig. 2 shows a typical synchronous motor having this frame construction.

Fig. 8—9500-Kv-a., Turbo Generator Showing Fabricated Frame Construction

In the waterwheel generators, the upper and lower brackets are of especial interest because of their radical departure from similar cast structures and their suitability to structural materials. Figs. 5 and 6 show these brackets and Fig. 7 a complete vertical machine.

Another excellent example is the frame construction of the new line of 3600-rev. per min. turbine generators shown in Figs. 8 and 9. This frame is built up of plates spaced periodically along the core. These plates support the frame bolts on which the punchings are stacked and at the same time provide the necessary air passages re-entrant ventilating system. Except for drilling the end plates which receive the punching bolt,s the whole structure is produced by the torch arc welder, and the bending rolls and presses in the structural shop.

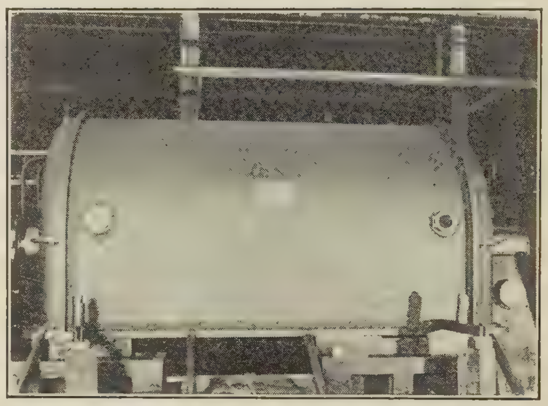


Fig. 9—9500-Kv-a. Turbo Generator Assemblor for Test

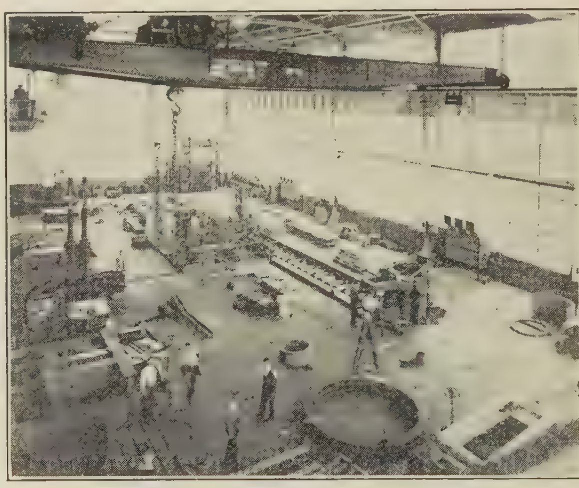


Fig. 11—General View of New Fabrication Shop

A plate on the back serves as a cover to the air passages and extends over the armature winding on each end where it meets the pressed steel end bells that are bolted to it. This structure is peculiar, in that while it is especially adapted to the fabricated steel construction, the completed machine can hardly be distinguished from the previous cast structures.

Another problem of the engineering department has been the "appearance problem." While some of the fabricated machines resemble closely their cast iron predecessors, many of them are radically different in appearance. It is a fact that what looks good to one

is simply a matter of what he is accustomed to. If one is accustomed to looking at cast machines, they look best, but as fabricated machines become more familiar they improve in appearance. What appears radical today seems commonplace tomorrow.

This was especially true in the case of fabricated H beam bedplates. Because of their appearance, they produced considerable unfavorable comment at first, and some customers actually refused to have them. But it is a fact that H beam bedplates are really better bases than cast bedplates. The U section of the cast bedplates, with its smoothly rounded corners, was not dictated by any requirement of the structure, but they were made that way so that the pattern could be pulled more easily from the sand. The idea of grouting bedplates into the top originated with the fabricated bedplate and when so grouted, its appearance is equally as good as that of the cast bedplate. It is just as natural to grout a fabricated bedplate into the top, as to set a cast base above the floor line. Architects are realizing this and are designing the floors of power houses and motor rooms with recesses to receive the bedplates, so that after the grouting is done, the floor covering can be placed flush with the top of the bedplates. And today, no one hears a word of criticism regarding the appearance of fabricated bedplates, and very little indeed, regarding the appearance of fabricated machines.

Round corners and sweeping curves are descriptive of cast structures and cast machines. Flat surfaces, square corners, and abrupt lines are equally descriptive of fabricated machines. It is only a matter of time when they will appear equally attractive; in fact, the straight line and the square corner have already come into prominence in the design of modernistic furniture, lighting fixtures, and decorations.

The major problem of the manufacturing department was the construction of a new fabrication shop. Fig. 11 gives a general view of the shop. The largest piece of equipment is a vertical bending roll for rolling into circles the frames of d-c. machines and the spider rims of a-c. machines. There is also a 1000-ton crimping press for putting an initial bend in the ends of the slabs to facilitate starting them in the rolls. A large furnace which will take slabs 37 ft. long is provided for heating the slabs preliminary to rolling, and also for annealing completed structures. An approach table is provided for carrying the slabs from the furnace to the crimper and the bending rolls. The furnace, approach table, crimper and bending rolls are all controlled from a single pulpit located near the rolling mill.

Other pieces of equipment include a flange press for forming the pressed steel end bells for turbine generators and a short blast room capable of receiving the largest completed fabricated structures. Here, all fabricated structures are shot ballasted before going to the assembly section. Every bit of rust and scale is removed so that when paint is applied to the surface there is no danger of its chipping or scaling off, because it has been applied to a surface 100 per cent clean.

MORE EFFICIENT HYDRO PLANTS

One of the most interesting features in the work of hydro-electric development has been the persistent endeavor to utilize to the fullest extent the potentially available energy of the water flow. Performances of mechanical equipment have been so consistently improved that for a given head and volume not only are the water-wheels designed for that service of remarkably high efficiencies but the products of different manufacturers come exceedingly close to duplicating results.

There has, comparatively recently, been a notable increase in the movement to utilize full stream flow by a series of generating stations located along the river course. The development of the Catawba River in the Carolinas by the Duke Power Company is representative of this "chain" planning, Oxford station being operated, to all intents and purposes, from the tailrace of the Rhodiss station and discharging into the pond of the Lookout Shoals station. The Chippewa Falls plant of the Northern States Power Company of Wisconsin follows a similar trend, being operated with the Wissota development, two miles upstream, in connection with storage reservoirs. Seasonal variations have, however, led to a further development at Chippewa.

By providing six comparatively small units at the Chippewa Falls plant it is possible to load the various machines to the point of maximum efficiency. In order that this efficiency may be maintained under varying conditions of operation, the propeller-type machines have been provided with movable blades whose pitch may be changed to give maximum efficiency for any gate opening or maximum output for any variation of head. This is a most interesting phase of hydraulic power development and should, if proved in service, be important in the future design of low-head plants. Steam stations have no monopoly of the economical features of good generating practices.—*Electrical World.*

LIGHT UP HOUSE NUMBERS ABROAD

Stockholm homes are to have illuminated street numbers this year, according to a report from the Swedish capital. Electrical experts have been asked to draw up plans for the necessary wiring, and the municipal authorities are expected to act upon them in the near future. The Stockholm Rent Payer's Association has gone on record as being highly in favor of the project.

Compulsory illumination of house numbers has been suggested in Stockholm before, but it was not until city doctors and cabmen began complaining of the difficulty of finding the right house number after dark that a vigorous campaign for lighted numbers was begun.—*Transactions, I. E. S.*

Electrical Features of the Kansas City
New Water Works

BY ALBERT L. MAILLARD
Member, A. I. E. E.

Synopsis.—*This paper describes the main electrical features of the new works recently constructed for additional water supply for Kansas City, Missouri. It enumerates the chief features of the power contract under which the city is purchasing its power. It states the type and capacities of the major electrical equipment and touches briefly on the wiring and lighting systems. It does not treat the efficiencies or the costs of the equipment.*

* * * * *

UNTIL comparatively recently standard waterworks practise was confined almost exclusively to the plunger type of pumps driven by reciprocating engines. They afforded economic operation over a wide range of conditions, but the floor space requirements and the capital investment were considerable. When it became expedient, in many cases, to install additional pumping capacity in a limited space and with limited funds, the turbo centrifugal pump received recognition. Its successful performance paved the way for electric motor centrifugal pumps which offered still further economies in capital investment. At the time when Kansas City was formulating its decision on the important question of steam-turbine or electric motor centrifugal pumps, standard practise, especially in the case of high-head pumpage, was strongly in favor of the former. In fact, of the thirty-five largest cities of the United States, only two or three used the electric motor as a prime mover, and one of these operated on "off-peak" power using storage reservoirs. Inasmuch as Kansas City is on a direct pumpage basis and cannot avail itself of the benefits of "off-peak" power rates, conditions are not exactly comparable.

Another factor which militated against electric drive in Kansas City was the fact that the city would be totally dependent, for its water, on purchased electric power with all the hazards, real and imaginary, that are involved in seven or eight miles of feeder lines, in addition to other likely causes of service interruptions. In consequence, the electrical layout had to be such as to give maximum assurance of continuity of service but still be kept within limited capital investment since the latter was one of the chief assets of electric drive. Inasmuch as a comparison of over-all costs, that is, fixed and operating charges, between steam and electric drive was made, it was necessary to have low power rates to offset increases in fixed charges.

POWER CONTRACT

At this stage it might be interesting to discuss the power contract between the city and the local public utility which contains some unusual features and which had some bearing on the selection of the type of equipment chosen. Some of the outstanding features of the contract are these:

1. That the city shall have first call on the power plants of the company.

2. That no substations shall intervene between the pumping stations and the power plant.

3. That duplicate feeders of very liberal capacity shall connect the stations with the power plant by two separate and independent routes.

4. That no other consumers shall be served by these feeders.

5. That the "off-peak" demands be calculated on a monthly average of daily half-hour peaks rather than on an individual half-hour.

6. That peak demands due to large fires, or emergency due to breakage of large mains, etc., not be considered in establishing the maximum demand.

7. That the peak months of water pumpage—viz.—June, July and August, not be considered in, establishing the maximum demand but be treated as individual months.

8. That a credit or debit be allowed or charged depending on the cost of fuel relative to a certain base price.

9. That a reduction in the demand charge be made based on 80 per cent power factor. Maintenance of 100 per cent power factor reduces the demand charge by 20 per cent.

The following are the rates:

Demand Charge:

$1.56¼ per month per kw., plus $3000.00 per month to cover charges on feeder lines.

Energy Charge:

$0.007 per kw-hr. until the demand at the high-lift station exceeds 2800 kw.

$0.00675 per kw-hr. until the demand at the high-lift station exceeds 4250 kw.

$0.0065 per kw-hr. until the demand at the high-lift station exceeds 5600 kw.

$0.00625 thereafter.

The life of the contract is twenty years but it may be terminated upon the giving of due notice by the city should the company fail to give first-class service.

1. Consulting Engineer, Kansas City, Missouri.

Presented at the Regional Meeting of the South West District No. 7, of the A. I. E. E., Dallas, Texas, May 7-9, 1929. Printed complete herein.

Choice of Motor Equipment

At the low-lift stations the range of head was very wide and since better pump efficiencies could be obtained with a change in speed, the two winding motors received considerable thought. A more careful examination of the head fluctuations disclosed the fact that the extremes in head variation occurred during only 20 per cent of the time. Based on the narrower limits of head variation, it was decided to use synchronous rather than two-winding induction motors. The former had the advantage of better efficiencies during 80 per cent of the time, better power factor at all times, less operating complications and slightly less cost; while the latter afforded better pump efficiencies for 20 per cent of the time. Besides, synchronous motors would raise the power factor made low by the many small induction motors in the purification works. The power factor clause in the power contract was a determining factor in the decision.

Accordingly, unity-power-factor, synchronous motors were selected for the low head stations and 0.8 power factor (leading) motors for the high head station.

Outdoor Substation Equipment

Power for the low-head stations is bought from the Kansas City Power & Light Company at 13,200 volts and is transformed to 2300 volts in an outdoor substation which is the property of the city. Two feeders, one overhead and the other underground, serve the station by two separate routes. The substation equipment comprises two 2500-kv-a. banks of transformers connected delta-delta. Each transformer is rated 833 kv-a., 13,200/2300 volts, single-phase, 60-cycle. These capacities were chosen on the basis that when overloaded 25 per cent one bank would carry 90 per cent of the ultimate load. Transformers are equipped with oil conservators and thermometers.

The two incoming feeders form a loop and are protected by directional relays. The overhead line is provided with a hairpin loop and oxide film arrester. Each bank of transformers is controlled by an oil circuit breaker on the high-tension as well as on the low-tension side and is differentially protected. A tie-line breaker on the high-tension side provides flexibility while the low-tension side is connected to a bus which is sectionalized by disconnecting switches. From this bus-four feeders, two to each station, supply the low and secondary station. Each station is fed from both sections of the bus.

The oil circuit breaker equipment comprises three 400-ampere, 25,000-volt and two 1200-ampere, 15,000-volt breakers, the latter of which are enclosed in switch houses. All breakers are hand operated with d-c. automatic trips. The direct current is furnished by a portable battery located in a meter house and connected to a battery charger.

At this station the power is metered on the high-tension side. Duplicate sets of metering transformers, one for the company and the other for the city, are installed on the structure. Duplicate sets of meters are located on the switchboard in the secondary pumping station. The metering equipment consists of recording demand and power-factor meters and integrating watthour meters.

Low-Lift Station

Water is pumped from the Missouri River to the purification works, about 2000 ft. away. The pumping station in which this initial pumping is done is known as the Low Lift Station. Each of the four main pumps in this station is driven by a 400-hp., unity power factor, synchronous motor operating at 2300 volts, three-phase, 60-cycle, 360-rev. per min. The excitation for these motors is supplied by two 30-kw. motor-generator sets. Each set is capable of furnishing excitation for five 400-hp. motors. These sets may be used for lighting in case of failure of the lighting transformer.

The control for this equipment comprises a fourteen-panel switchboard on a gallery floor 28 ft. above the pump room floor. A mechanical remote-control system through bell cranks and pull rods operates the oil circuit breakers which are supported on a pipe framework and are located on another gallery 12 ft. below the switchboard floor.

The main bus is sectionalized by two oil circuit breakers. In the section between these breakers there is connected a station service feeder which serves power, lighting, and heating transformers. Each outside section of the bus is fed by an incoming feeder, each feeder having the capacity of the entire station. One section serves two motors, while the other serves the remaining two motors and the future unit.

Motor starting is accomplished by means of compensators and a starting bus. This bus is sectionalized by disconnecting switches, each section being served by a compensator. Each compensator is of sufficient capacity to permit of four starting operations within 10 min. without excessive heating of the compensator. In this station there are eleven 600-ampere and four 400-ampere, 7500-volt oil circuit breakers.

Auxiliary power for operating vacuum pumps, sump pumps, motor-generator sets, crane and gate valves in this building as well as the revolving screens in the intake building is obtained from three 25-kv-a., 2300/230-volt transformers connected delta-delta. The lighting transformer is rated at 15 kv-a., 2300/230/115 volts.

Both the intake building and the low-lift station are heated electrically and are served by a 150-kv-a., three-phase, 2300/230-volt transformer. Industrial oven type, 220-volt ribbon element heaters suitably mounted and backed with reflecting and insulating material and provided with grill work in the front are placed along the gallery in a manner similar to steam radiator practise. In most locations two elements are used to form

one radiator but they are individually controlled by local switches so that flexibility in controlling the heat may be obtained. All the transformers in this station are controlled by one oil circuit breaker but are protected by individual S & C fused disconnecting switches.

Secondary-Lift Pumping Station

After the water has been purified it is pumped to reservoirs at the high-head stations. This being the second stage of pumping gives to the station the name of secondary lift pumping station. The pumping capacity of this station is the same as that of the low-lift station and since the heads are about equal, the electrical equipment is a duplication of that at the low-lift station. In addition to the main pumping units and the vacuum pump motors there are three 75-hp., 2300-volt, 1800-rev. per min. motors driving wash water pumps, two 60-hp., 2300-volt, 1800-rev. per min., and two 25-hp., 220-volt, 1800-rev. per min. motors driving house service pumps. The 75-hp. motors are controlled by automatic "across-the-line" contactors and push buttons. Each motor may be controlled from any one of three points. The 60-hp. motors are started across the line by closing the oil circuit breaker. The 25-hp. motors are controlled by starting compensators.

In addition to these pump motors all the power used in the chemical house, chlorine house, filter house, Dorr clarifiers, and the lighting for all these buildings and the grounds are controlled from the switchboard in the secondary-lift station. In the chemical house there are about 150 hp. in motors ranging in size from ¼- to 50-hp. Four 7½-hp. motors operate the Dorr clarifier mechanisms.

The switchboard comprises 21 panels and the system is that of mechanical remote-control, with the main oil circuit breakers and bus located on the lower floor in a switch-room beneath the switchboard. The starting bus, its compensators, and oil circuit breakers are located at the back of the switchboard. The busses are sectionalized in a manner similar to those at the low-lift station, but between the sectionalizing breakers there are two feeders, one for power and one for light. This building is not electrically heated. In the chemist's laboratory, however, there are ovens, sterilizers, refrigerators, distillers, etc. Another small difference between this station and the low-lift station is that the field rheostats for the main motors are electrically controlled in this station. The 36-in. discharge valves in both stations are electrically operated.

There are seventeen 600-ampere and four 400-ampere, 7500-volt oil circuit breakers in this station.

The auxiliary power transformers comprise three 75-kv-a., 2300/230-volt units connected delta-delta. Multiple lighting is served by a 75-kv-a., 2300/230/115-volt transformer, and series lighting by an 8-kv-a. constant-current transformer.

Lighting and Wiring

Lighting in almost all the buildings is laid out to give at the working plane an intensity of six foot-candles exclusive of a liberal allowance for dust and aging of the lighting units. In the filter galleries, this intensity is maintained but over the filters and in the pipe galleries a lower intensity is used. A generous number of wall receptacles is installed. Glass and fancy fixtures are omitted, porcelain enameled steel reflectors being used instead. The installation is substantial and put up to stay for many years. Galvanized iron conduit and condulets are used throughout. Wire is 30 per cent para, double braided, except in damp places where triple braided weatherproof wire is used. Waterproof fixtures are used in such places.

Around the uncovered basins flood lighting projectors, standing two feet above the ground, are used. Thisi s done to reduce the number of bugs which swarm around lights, die, and fall in the water. At each flood light location there are three waterproof condulets, one for connecting the projector, another housing a switch for controlling the projector, and the third, a receptacle. The receptacle permits the concentration of more than one projector at a location during periods of cleaning of the basin. The projectors are fed by armored cable laid from 12 to 18 in. in the ground. At various manholes, lights, switches and receptacles are located and connected to the same cable system. About other parts of the purification works, there are distributed lighting standards for general illumination. Along the roads leading to the pumping station there are similar standards. They are all connected to a series system which is served by a constant current transformer in the secondary-lift station and operated at 6.6 amperes.

Power Cables

All power cables are insulated with varnished cambric and are lead covered where they are installed in pump-room floors or other places that are likely to be damp or flooded with water. Standard 5000-volt insulation is used on 2300-volt circuits and 17,000-volt insulation on 13,200-volt circuits. On 2300-volt circuits 7500-volt potheads are used. The control wiring for the East Bottoms Station is lead covered.

Underground Cable System

Between the outdoor substation and the low- and secondary-lift pumping stations as well as between the secondary station and the chlorine and chemical houses the feeders are three conductor, varnished cambric insulated, lead covered cables installed in fiber ducts surrounded by a concrete envelope. Cables vary in size from No. 6 A. W. G. to 800,000 circular mils. Conduits vary from four to ten ducts. Concrete manholes, properly drained, are installed at frequent intervals.

East Bottoms Stations

The new electrically operated high-head station is

known as the East Bottoms Station and is located about five miles from the purification works. The present main motor equipment consists of two 2000-hp., 0.80 power-factor (leading) 13,200-volt, three-phase, 720-rev. per min. motors equipped with direct-connected exciters. They are provided with temperature detectors and enclosing bell ends. The station is planned for six such motors.

The switchboard comprises 14 panels at present but will ultimately be expanded to 21. The system is that of electrical remote control, some operations being performed by manually operating the control switches while others are automatically controlled by relays and interlocks. The front of the switchboard faces the pump room, while access to the back is had from the switch house. All busses and switching equipment, oil circuit breakers, instrument transformers, compensators, etc., are enclosed in a monolithic concrete cell structure.

The station is fed by two 13,200-volt lines direct from the public utility's power-house bus. Ultimately there will be four such feeders. The main bus in the station is in duplicate but may be made a continuous bus by use of a tie breaker at one end of the bus structure. Indicator lights are located over the disconnecting switch compartments of the cell structure to show the position of the controlling oil circuit breaker.

The oil circuit breaker equipment comprises one 600-ampere, and seven 400-ampere, 15,000-volt units each rated at 14,000 r. m. s. amperes at 15,000 volts, and four 400-ampere, 15,000-volt units each rated at 1500 r. m. s. amperes at 1500 volts. All but two breakers are of the phase per cell type. The breakers are all solenoid operated and the control current is supplied by a storage battery. A small motor-generator set furnishes the trickle charge for the battery.

Motor starting is accomplished by compensator and starting bus as in the other stations but in addition neutral breakers provide a smoother transition from starting to running voltage. Motors have 85 per cent pull-in torque and full voltage is applied before the field circuit is closed.

At this point, the sequence of operations in starting a motor might be interesting. First, the neutral breaker is closed by closing its control switch, which operation automatically closes the compensator breaker. Next, the starting breaker control switch is closed. An accelerating relay controls the next steps. As it closes, it trips the neutral breaker which in turn closes the running breaker. The field breaker control switch is then closed and the compensator breaker control switch, which is the same as the neutral breaker control switch, is opened, which automatically trips the starting breaker. If the field breaker be not closed within ten seconds after closure of the running breaker, the field failure relay trips the running breaker. This time limit has been set on account of hydraulic conditions.

With the closure of the running breaker, a solenoid valve on the automatic check valve is closed. This will be described more fully later. Due to the fact that this solenoid valve closes only after the running breaker is closed, the motor "pulls in" against a closed discharge because the check valve cannot open while the solenoid valve is open. This reduces the required pull-in torque of the motor.

In this station there is a 30-kw. motor generator set which is capable of performing four important functions. It can supply excitation for any one or two of the main motors. It provides a source of direct current for lighting; it can give a full charge to the battery; it provides current for the control circuit while the battery is out of service or being charged.

Auxiliaries are fed from a bank of three 25-kv-a., 13,200/230-volt transformers. Lighting is supplied by a 25-kv-a., 13,200/230/115-volt transformer. Emergency lights are fed from the battery and go on automatically whenever the lighting transformer is out of service.

The description of this station would be incomplete without a word about the automatic stop and check valve. It opens and closes automatically with unbalance of hydraulic conditions in the valve. The necessary unbalance of hydraulic conditions may be controlled by a solenoid-operated valve in the blow-off line of the main valve. The solenoid circuit is interlocked with the running breaker and a control switch on the switchboard is inserted in the circuit. With the closing of the running breaker the solenoid valve closes and permits the main valve to open as soon as the pressure on the pump side of the valve becomes greater than that on the line side. As soon as the running breaker trips out, the solenoid valve opens and the main valve closes. The control switch on the board permits the operator to open the solenoid valve circuit, thereby opening the solenoid valve, which in turn closes the main valve even with the pump operating at normal speed. The operation of the main valve may be noted by the pressure-gage reading. This permits of the checking of one of the most important automatic features of the station without disturbing normal operation.

The use of 13,200-volt motors and electric radiators for building heating are radical steps in waterworks practise. It must be realized that the city is entirely dependent upon electrical power for its water. Moreover, this electric power is being purchased from the local public utility. It is a great tribute to the reliability of electric public utility service and to the electrical industry as a whole.

By a decisive vote, the citizens of Sioux Falls, South Dakota, refused to issue $100,000 in bonds for the enlargement of the municipal power plant. This is considered to be a victory for the Northern States Power Company which operates in Sioux Falls.

Fused Arcing Horns and Grading Rings

Design, Construction, and Operating Experience on 66,000-Volt Transmission Lines of the Union Gas & Electric Company

BY PHILIP STEWART[1]

Associate, A. I. E. E.

Synopsis.—This paper considers the use of fuses on insulator strings of high-voltage overhead conductors, to interrupt the arc at times of flashover before the line relays operate to disconnect the circuit. Consideration is first given to the original development of this idea, in which a fuse was connected between the line conductor and an arcing ring, attached to the second insulator unit. When an excessive voltage occurs on the conductor to ground, there is a flash between a two-pronged horn on the top insulator unit and the ring. The circuit is completed through the fuse, which immediately opens, breaking the arc. Further consideration is given to a later development of the principle, in which two expulsion type fuses replace the two-pronged horn at the top of the insulator string and the arcing ring is placed at the conductor end of the string. Data are presented from tests and from experience on about 100 mi. of 66,000-volt circuit, of the Union Gas and Electric Company, Cincinnati, Ohio.

Introduction

The general practise up to this time is to isolate faults at the ends of feeders or transmission circuits in trouble. This is done by means of oil circuit breakers actuated by relays. Lines and circuits so equipped immediately go out of service in case of faults. The fused insulator string is a device for isolating faults right at the point where the fault occurs, interrupting fault current only, and not interrupting the useful service of the line or circuit.

It is now generally considered good practise to provide some arrangement of arcing or grading rings or horns, at all insulator strings of important high-voltage transmission circuits. Experience and tests point to this means of preventing cascading and possible shattering of insulators by flashovers caused by transient voltages on the line conductors to ground. The use of such devices reduce the time the line may be out of service, due to flashed insulators. The development of the fused device for insulator strings is an attempt to further reduce the interruptions, especially those of short duration caused by the line switch opening to clear the surge flashover and subsequent short circuit which may last for only a few seconds.

One of the two generating plants in the Cincinnati territory is located at Columbia Park, on the Ohio River, about 20 mi. west of Cincinnati. This plant is operated as a base load station at as nearly full load as possible at all times. The major part of the load from Columbia to Cincinnati is carried over four 66,000-volt transmission circuits carried on two double circuit tower lines. These circuits are connected to Terminal Switching Station, north of Cincinnati. From Terminal Station, two 66,000-volt circuits connect to each of three major distribution substations. Two circuits also connect to the system of the Dayton Power and Light Company.

It is very important for the operation of the entire system that these circuits be kept in service without interruptions. It is especially so on the circuits from Columbia to Terminal Station. When these lines were built, the insulator strings were equipped with flux controls. Six insulator units were used in each string. The first year's operation was good, but the disastrous results of insulator flashovers and line outages were evident.

Original Development

The first arrangement using fused arcing rings consisted of a string of seven insulator units and was provided with two horns at the top and a split oval ring below the fifth unit. Fuse clamps were mounted on the ring and conductor clamp, thus shunting the two lowest insulators with a fuse. With the fuse in, the line is insulated with five units between the line and ground. After the fuse has been blown, the insulator will consist of seven units. In this way the flashover distance will be increased and it was thought that in case a second surge originated near this point before the fuse was renewed, the flashover would occur at the next adjacent point of support.

Tests were made with this arrangement to observe the performance in clearing flashovers on the 66,000-volt system. All 66,000-volt lines were energized into Terminal. The tests were made on a line from the main bus. The insulator string was shunted by a piece of small copper wire in order to start the flashover. The line was closed in on the shorted insulator by means of the station oil circuit breaker. An oscillograph was used in order to obtain the short-circuit currents and voltages. An average short-circuit current of 2970 r. m. s. amperes was obtained, with 9000 volts, phase to neutral, during short circuit. The 10-ampere 37,000-volt carbon tetrachloride fuses cleared in one cycle, in each case clearing before the relays operated to open the oil circuit breaker.

Tests were made in the high-voltage laboratory of the General Electric Company. In these tests it was established that a power arc can be produced by fusing

1. Union Gas & Electric Company, Cincinnati, Ohio.

Presented at the Regional Meeting of the Middle Eastern District of the A. I. E. E., Cincinnati, Ohio, March 20-22, 1929. Printed complete herein.

a fine copper wire connected between the arcing rings of an insulator string. This method of starting an arc was used throughout.

Tests were also made to investigate the performance of the fused rings when subjected to artificial lightning; first with a ring made of 1½-in. pipe, then a strap iron ring, and in the third case the horns were supplied with hemispheres. These three tests gave approximately the same flashover voltages and arcing characteristics, thereby indicating that for this short string, grading is not so necessary. The average flashover voltage determined in these tests was 530 kv. maximum, which is the same as the flashover voltage between needle points placed the same distance apart. This indicates that the voltage distribution on the comparatively short string of insulator units does not affect the flashover of the parallel gap. However, on longer strings, grading is necessary, and the multi-gap effect of the units must be overcome.

Further tests determined the effect of artificial lightning discharge on the fuse alone. Ten discharges of approximately 6000 amperes (maximum) had no apparent effect upon the fuse, due to the exceedingly short time during which the current was flowing. This shows that the fuse is probably blown by the follow-up current and not by initial current due to the lightning discharge.

Operating Experience

In the spring of 1927, fused arcing rings were installed on two of the Columbia—Terminal circuits, and four of the shorter lines, leaving Terminal, totaling approximately 65 mi. of circuit so equipped. During an eight month period succeeding this installation, there were six cases of the fuses blowing and clearing without an interruption to service. There were three cases in which the fuses failed to clear and the circuit breaker opened, interrupting service on the line. During this period, ten fuses were blown. The three service interruptions were caused by the destruction of the fuses at the flashover points.

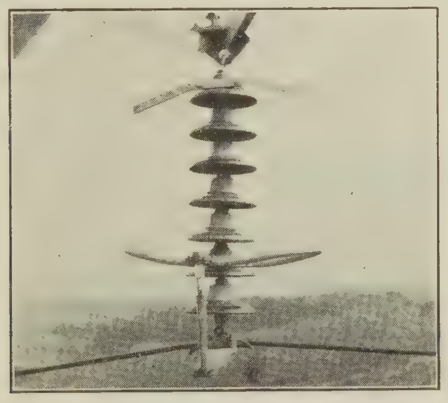


Fig. 1—Original Development of Fused Arcing Ring Using Carbon Tetrachloride Fuses

It is noted that the fuses functioned properly 77 per cent of the time and succeeded in preventing service interruptions 67 per cent of the time.

All failures of the device were due to failures of the fuse itself, caused by follow-up surge voltages. One case noted during the preliminary tests probably explains these failures. A blown fuse was inserted and an impact of very high voltage was applied. The arc followed a path from the conductor over the metallic part of the fuse within the glass tube, puncturing the glass, and passing over the outside to the ring and to the horn and ground. In actual practise, a dynamic arc would follow this first arc, causing destruction of the fuse.

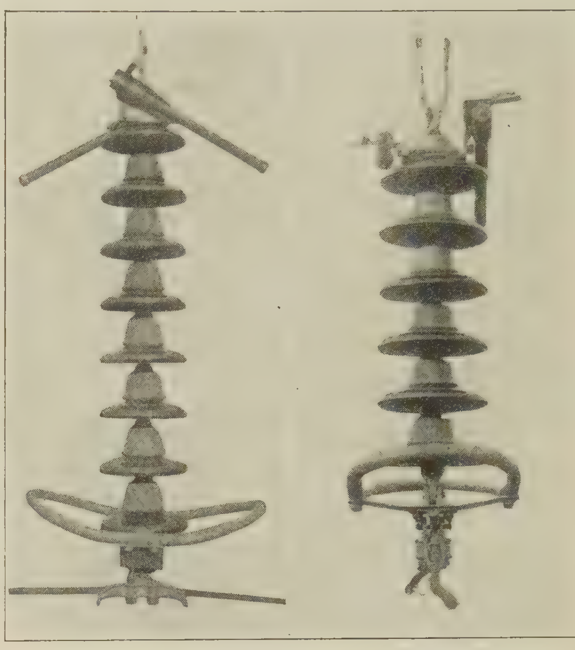


Fig. 2—Later Development of Fused Insulator String Using Expulsion Type Fuses as Arcing Horns

Development Using Expulsion Type Fuse

The operation of the fused arcing rings, using carbon tetrachloride fuses, (Fig. 1) was successful in preventing a number of service interruptions on the two Columbia—Terminal circuits on which they were installed. In considering the installation on the two remaining circuits, a more economical arrangement of the device was desired. First, the added cost for the extra insulator units shunted by the fuses did not seem to be justified by the first year's operation. Second, the carbon tetrachloride fuses were more expensive than expulsion type fuses. Therefore, the next development was an arrangement using two expulsion type fuses in place of the horn at the top of the insulator string, (Fig. 2) and a ring at the conductor end.

Tests were made on various makes of expulsion type fuses, some the standard products of different manufacturers and some specially designed by the Union

Gas and Electric Company. These tests were made at Terminal Station with the system set-up similar to that of the previous tests. In each case the fuse operated correctly to break the short circuit. The time required with a few exceptions was one-half cycle or less.

Further tests to determine the conductivity of the fuses after they had been blown established that there was practically no conducting material deposited in the fuse holder.

The diameter of the ring and the position of the fused horns were determined from tests made with the impulse generator of the General Electric Company so that flashovers on the assembled string occur from the end of the fuse to the ring without cascading.

In addition to more economical construction, the present assembly has an advantage over the original in that two fuses are employed. It was established by tests that both fuses will not blow at the same time, but one will remain in good condition. When one fuse is blown the arcing distance on that side is greater than on the side of the good fuse and second flashovers go to the tip of the good fuse. Therefore, the device will function for two consecutive surges originating on the same section of line before replacement of the fuses is necessary.

OPERATING RECORD WITH FUSED ARCING HORNS

Line	Year	Interruptions	Flashed units	Type of fuse	Interruptions prevented	Fuses blown
1761	1926	3	30	none		
	1927	2	6	S. & C.	4	9
	1928	0	0	S. & C	1	1
1762	1926	4	14	none		
	1927	1	2	S. & C.	2	4
	1928	0	0	S. & C.	1	1
1763	1926	1	0	none		
	1927	4	18	none		
	1928	0	0	Expulsion	1	1
1764	1926	2	6	none		
	1927	3	24	none		
	1928	0	0	Expulsion	1	1
1261	1926	1	0	none		
	1927	0	0	S. & C.	0	0
	1928	1*	0	S. & C.	*	2
1262	1926	3	6	none		
	1927	0	0	S & C.	0	0
	1928	1*	6	S. & C	*	1
861	1926	0	0	none		
	1927	0	0	S. & C.	0	0
	1928	0	0	S. & C.	2	3
862	1926	0	0	none		
	1927	0	0	S. & C.	0	0
	1928	2	0	S. & C.	0	3

*Flashover at substation.

Upon operation, a bright metal clamp at the out end of the fuse is blown off and the condition of the fuses can be determined by patrolmen's visual inspection from the ground.

Operation in 1928

In the early part of 1928, the fused horns and grading rings were installed on the two Columbia—Terminal circuits not previously equipped with fused arcing rings. During this year there were no interruptions to service on any of these four circuits. Although there were comparatively few lightning storms, four fuses were found blown, indicating that they had been effective in preventing service interruptions.

For two years operation, there have been seventeen cases of flashovers on lines equipped with fused horns or arcing rings. Of these cases twelve interruptions have been prevented. This is an elimination of 70 per cent of service interruptions.

The accompanying table shows the operation record for the 66,000-volt tower lines during three years of service.

Conclusions

1. Arcing rings are essential equipment on important high-voltage transmission lines. Without arcing rings, many insulators are flashed and shattered due to cascading of the string. Shattered insulators mean a line outage for several hours caused by an abnormal condition existing only a fraction of a second.

2. Fuses in the flashover circuit interrupt and prevent the flow of follow-up current. Since the fuses function in approximately one-half cycle and protective relays are ordinarily set to operate in not less than 35 to 45 cycles, the short circuit will be cleared before the oil circuit breaker operates.

3. The fuse is not blown by the current of the initial surge, but by the current of the dynamic arc.

4. The use of fused insulator strings on the high-voltage circuits of the Union Gas and Electric Company has been a large factor in a considerable improvement in service and operating records.

5. Tests and operating experience, as well as economic considerations, show several advantages of the assembly using fused horns at the support end of the string, over the original assembly using a fused ring at the conductor end.

6. The adoption of fused horns and grading rings for important high-voltage lines has proved to be another means by which service and operation may be improved.

CORRESPONDENCE

To the Editor:

I wish to direct attention to a change which should have been made in the paper *Field Tests of the Deion Circuit Breaker* published in the JOURNAL for February 1929.

On page 104 of the February JOURNAL the last sentence of the first paragraph should end as follows: "the main current-carrying contacts were apparently in a condition to carry normal rated current *without* excessive heating at the end of the Chicago tests."

Yours very truly,

B. G. JAMIESON.

Abridgment of

Arc Welding of Steel Buildings and Bridges

BY FRANK P. McKIBBEN[1]

Non-member

Synopsis.—*The paper treats of the important matters of the revision of building codes, the preparation of specifications for welded buildings, the accumulation of cost data, the training of designers, the qualification of welders and inspectors, and additional tests of welded joints, which are now receiving attention. Investigations made toward the definite betterment of present conditions are cited and in the appendix are given proposed specifications for the arc-welding of steel buildings, with regard to general application, definitions, quality of structural steel and welding electrodes, welding apparatus, workmanship, qualifications of welders, the proportioning of parts and the protection of steel.*

* * * * *

THE art of welding structural steel by electricity is developing rapidly, and this year witnesses many applications of this process to the construction and reinforcement of bridges and buildings. The electric arc furnished designing engineers with a new tool which has been widely adopted not only in the fabricating of bridges and buildings, but also in many factories for welding parts of machinery and assembling structural steel sections as substitutes for castings.

That with proper supervision of design and workmanship, one can secure safe construction is evidenced by the existence of over 60 welded buildings, in which no failures have been recorded. For a new type of construction, this is truly a remarkable record, but, we must not forget that welded construction in its early stages has received far more experimentation and more careful supervision in execution than did concrete or riveted work at the corresponding stages of their development.

Among the most important matters now receiving attention are revision of building codes, preparation of specifications for welded buildings, accumulation of cost data, training of designers, the qualification of welders and inspectors, and additional tests of welded joints.

Many municipalities are not revising their building codes in order to bring them in closer harmony with recent improvements in building construction. Among the changes being considered by many cities are the increase from the 16,000-lb. to the 18,000-lb. basis for structural steel and the permission to erect-welded steel building frames. Over 40 municipalities have already made provisions for welding in their codes, and many others, such as New York, Pittsburgh, Chicago, and Philadelphia, have committees at work on code revision. It is appropriate and timely that these committees should give proper consideration to the use of welding, and adopt the unit stresses for use in steel building design recently decided upon by the American Welding Society in its building code, thus bringing nearer a uniform building code, so long desired by architects and structural engineers.

The elimination of noise is not the only desirable quality possessed by welding. Of equal value is the very considerable reduction in weight of steel effected in many cases. This latter feature was very well illustrated in the building at the General Electric Company's West Philadelphia plant, in which roof trusses were built without the use of a single rivet, thus eliminating over a thousand steel gusset plates each approximately 17 in. by 29 in. in size. Moreover, the absence of rivet holes in the tension members made less steel possible in these members. These and other

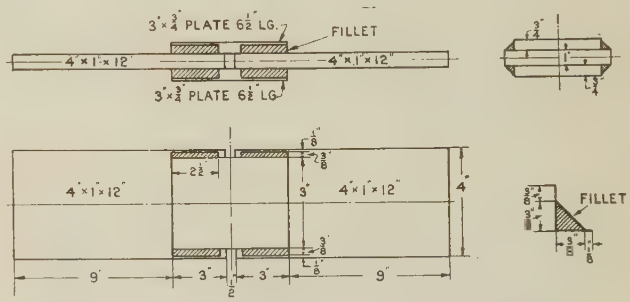


FIG. 1—TEST SPECIMENS FOR FILLET WELDS

savings resulting in reducing the weight of each of a series of roof trusses of 58-ft., 6-in. spans from 6800 lb. for a riveted truss to 5000 lb. for a welded truss carrying the same loads; and of 78-ft. trusses, from 13,200 lb. riveted to 9200 lb. welded. These are very considerable reductions in weight and should result in lower costs.

Much attention is being paid to the qualification of welders for structural steel welding, and the tendency is to exaggerate the importance of this matter. Good welders are wanted and they can be secured by testing applicants with some welding which, though reasonably simple, is sufficiently searching to insure capable men. Three types of tests are outlined, any one of which may be made the basis of qualifying welders; that is, for ascertaining whether a welder's experience is such as to enable him to properly perform work on steel buildings, which happens to be one of the simplest forms of welded construction. The best and most searching

1. Consulting Engineer, General Electric Co., Black Gap, Pa.

Presented at the Middle Eastern District of the A. I. E. E., Cincinnati, Ohio, March 20-22, 1929. Complete copies upon request.

qualifying test is to have the applicant weld a steel sample specimen in which the welds are subjected in a tension-testing machine to longitudinal shearing, to determine the ultimate stress. This longitudinal shearing strength is a measure of the welder's ability to weld, and if the average of his specimens is 42,000 lb. per square inch, or more, he should be acceptable. It is neither necessary nor desirable, for municipalities to require each welder to demonstrate his ability to the city's building inspector, but rather to require each contractor who fabricates or erects steel buildings to give evidence that his welders have qualified. The simplest way is for the contractor to have his welders make up some test specimens, submit these to a responsible laboratory for testing and exhibit the report of the laboratory as evidence of the welders' qualifications, all of which can be done under supervision of the architect's or engineer's inspector.

The average of a series of ten test specimens made by five welders in a steel fabricating shop is given as 44,000 lb. per square in., longitudinal shearing value, and although there is a variation of about 25 per cent between the strength of specimens made by the best and poorest welders, the results of each individual man are in very close agreement.

A good inspector can learn a good deal about a fillet by visual inspection. Rounded edges denote lack of penetration of fillet into parent metal; *i. e.*, into parts being welded; one short and one long side of a triangular fillet indicate that the wire electrode has been held at an incorrect angle of welding; a crater at any point in a fillet other than the end is evidence that the arc has been broken and the fillet not laid continuously; numerous gas holes on the surface of a fillet indicate too long an arc and a lack of penetration; a current (shown by the ammeter on the welding machine) too great for thin plates or too light for thick ones, is undesirable, and the inspector should see that the welders adjust their machines to obtain the current suitable for the thickness of the material being welded.

In comparing the lengths of fillets actually deposited in the shop with those designated on the drawings, it has been the writer's experience that generally the total of measured deposits exceeds the total compiled from drawings; but now and then an individual fillet may be either greater or less than designated. For example, at the welding shop of the American Bridge Company at Trenton, the total fillets on one welded truss aggregated 633⅛ linear in. as compared with 598 in. specified. And while the maximum excess of actual length of an individual deposit over that specified reached as much as 52 per cent, in two other fillets deficits of 8.8 per cent and 10 per cent, respectively, occurred. These deficits are not due exclusively to the welder, but sometimes may be attributed to inaccuracies on drawings where a specified length of fillet is impossible of execution.

Although sufficient tests are available to enable designers to proportion safe joints in ordinary building construction, additional tests are needed to provide for the future extensive use of welding which now seems assured. Two types of tests are possible; first, shearing; and second, direct-tension or compression.

In shear the welds are subjected to either transverse or longitudinal shear, and it is on the latter that very good test data are available, while on the former, some additional work should be done. Indeed, on longitudinal shearing tests, some interesting problems remain unsolved; these are; first, the relation between longitudinal shearing strength and lengths of fillets, or what amounts to much the same thing, the exact distribution of stress along the length of a given welded fillet; second, the relation between the longitudinal shearing strength and the size of the fillet; for example, will the strength per linear in. of a ½-in. fillet be double that of a ¼-in. fillet? Third, relation between longitudinal shearing

Fig. 2—Showing Building with 56-Arc-Welded Roof Trusses of General Electric Co. at West Philadelphia, Pa.

strength and the number of layers used in depositing the fillet material.

Existing tests indicate greater shearing strengths of fillets in transverse than in longitudinal shear.

Transverse shear appears in fillets laid at right angles to the axis of the member being connected, while longitudinal shear is exhibited in fillets laid parallel to the axis. For a member having a symmetrical cross-section, (rectangular, for example), one would expect transverse fillets to be stronger than longitudinal fillets, because each inch of fillet is subjected to the same stress, whereas in a fillet subjected to longitudinal shear, some inches are carrying little stress while others are working at the maximum. The case is analogous to a riveted joint, in that when a number of rivets are placed parallel to the stress, the load carried by the several rivets varies greatly; whereas when they are spaced in a row at right angles to the load, the rivets may be made to perform equal work.

Tensile and compressive stresses in welds are en-

countered in butt joints. Tensile butt joints are very common, as, for example, in longitudinal seams of tanks or pipes subjected to internal pressures. Compressive butt joints are much less frequently used. They may appear in splicing compressive members—a top chord of an ordinary truss for example,—but even here, splice plates with longitudinal shear on fillet welds might be used. For tensile butt welded joints, ample data are available to enable us to design tanks, pipes and similar structures.

Fig. 3—Details of Column Anchors

Typical test data for longitudinal shear of $\frac{3}{8}$-in. fillets with triangular cross-sections presented in the paper show an average ultimate shearing strength of 13,354 lb. per linear inch of fillet corresponding to 50,200 lb. per square in. of minimum net shearing area of the fillet (the throat), *i. e.*, the section passing through the apex of the fillet's cross-section and perpendicular to its hypothenuse. The above longitudinal shearing values are found from specimens tested in tension, but those found from compressive specimens are quite considerably higher.

The American Welding Society's Committee on Building Codes has adopted a safe working unit shearing strength of 11,300 lb. per square inch which, for a $\frac{3}{8}$-in. fillet in longitudinal shear is 3000 lb. per linear inch of fillet. Let us examine this. The throat distance of a $\frac{3}{8}$-in. fillet being 0.266 in., the product of 11,300 and 0.266 gives 3000 lb. per linear inch. As the test data give 13,354 lb. per linear inch, or 50,200 lb. per square inch, these values of 3000 and 11,300 of the American Welding Society's Committee correspond to a factor of safety of 4.4 which is conservative.

Adopting 11,300 lb. per square inch for the safe allowable unit stress in longitudinal shear, the following working strengths are evident; for $\frac{1}{2}$-in. fillet, 4000 lb. per linear inch; for $\frac{3}{8}$-in. fillets, 3000 lb. per linear inch; for $\frac{1}{4}$-in. fillets, 2000 lb. per linear inch. Notice that for each $\frac{1}{8}$ increase in size of fillet, an increase of 1000 lb. per linear inch in the allowable unit shearing stress is permitted.

Three Buildings in Which Arc Welding was Used

During the past year, the General Electric Company has completed a building in West Philadelphia, Pa., one in Bridgeport, Conn., and one in Pittsfield, Mass. in all of which the steel is connected principally by arc welding.

Welded Trusses in West Philadelphia Building

The West Philadelphia building consists of a head house 78 ft. wide by 171 ft. long, with vertical clearance of 43 ft. below bottom chords of trusses, of one aisle 59 ft. by 474 ft., and of a second aisle 79 ft. by 474 ft. These aisles and the head house comprise a building approximately 138 ft. by 552 ft. Supporting the roof over these various parts are trusses of the Pratt type with horizontal chords in the two main aisles and a sloping top chord in head house. Each chord is an 8-in. H section with horizontal web, while each diagonal consists generally of two small channels with their backs lying in contact with, and on the outside of, the vertical flanges of the H chords, to which the channels are welded by fillet welds. Ordinarily each vertical member of each truss is a 7-in. I-beam which fits into the trough of the top and bottom chords, to the vertical flanges of which it is welded. These direct connections of web members to chords obviated the use of gusset plates at truss joints.

Fig. 4—Welded Trusses Erected in Position between other Buildings

In any building consisting of a main aisle and a transept, especially where there is a traveling crane in the latter, the truss at the intersection of transept and head house is somewhat difficult to arrange. In this building, a truss $17\frac{1}{2}$ ft. deep spans the main aisle, supports a portion of a roof load, the clear story, a roof truss in the head house, and a head house runway

girder spanning the 59-ft. aisle. On account of its depth, this truss was shipped in parts, assembled lying flat on the ground, welded, and erected. All other trusses were completely welded in the shop, and after erection, were welded to the supporting columns with sufficient bolts to hold them in position,

In addition to 10-ton bridge cranes in the head house and in the 59 ft. main aisle, this building has several smaller bridge and wall cranes.

Welded Trusses at Bridgeport, Conn.

The Bridgeport building code is a flexible one, in that it authorizes the Building Commission to permit

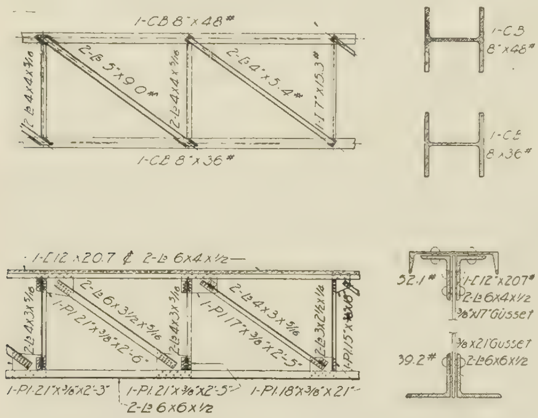


Fig. 5—Welded and Riveted Typical Panels and Chord Sections Pratt Type Truss

the use of new materials if after investigation the Commission is satisfied that the new type is safe and satisfactory. After a study of tests data of welded joints, the Commission granted a permit for the General Electric Company's welded steel building which connects two existing buildings. This is a one-story structure with roof trusses of 62-ft. span supported on side wall columns. The interesting details here are the use of T-shaped top and bottom chords, the truss end bearings at the tops of columns and the splice at center of top chord. By cutting the web of an H section along its center, thus forming two T's for chords to which web members are welded directly, all gusset plates were eliminated. Beams can be cut in this manner either by cutting with the oxyacetylene flame, or by punching. At the bearing of vertical web of this top chord T on the base plate, which, in turn, rests on the column cap, stiffener plates are shop welded to the T-web.

As the roof of this building slopes downward from the center line towards the ends of the truss, the top chord is given a similar contour, thus necessitating a splice in the top chord at the center. This is accomplished by a butt splice with a single V in the horizontal flanges of the T, while the vertical web is spliced on each side by a leg of a web member connected by fillet welds. As the roof trusses were fabricated completely in the shop by welding, the field welding consisted principally of connecting the top and bottom chords to the columns.

Welded Factory Building at Pittsfield, Mass.

This structure is two stories high in part, and three stories high elsewhere; length, 280 ft.; width, over-all, 60 ft., with approximately 40 ft. between centers of outside wall columns. The interest here lies entirely in the structural details, among which may be included the following:

a. Connection of a 27-in. main floor girder to the side wall column by a shop welded angle bracket upon which the girder rests and by field welding the girder web to face of the column as well as field welding the top and bottom flanges to the face of the column. The ends of these 27-in. girders were milled.

b. Connection of main 18-in. floor beams to web of 27-in. main floor girders by resting the beams on heavy angle brackets shop welded to girder webs. These seat angles were designed to take the loads to which they were subjected.

c. The use of flat bars as stiffeners welded to the vertical webs at the center of 27-in. main floor girders where these rest upon short columns extending from foundation to second floor level only.

All shop and field welding on the above buildings was performed by single operator, motor-driven generator sets. For depositing 3/8-in. fillets on metal 3/8 in. or more in thickness, the current was about 185 amperes,

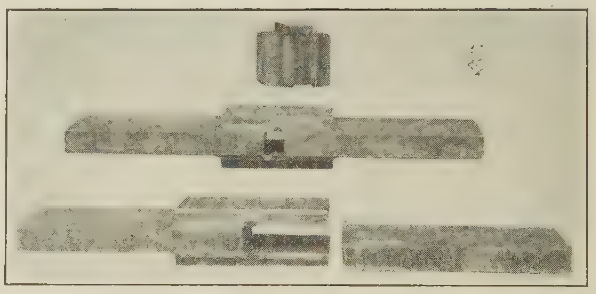


Fig. 6—Tests on Welded Structural Steel Showing Compression and Tension Specimens after Failure

3/16-in. electrodes, arc voltage 20, with smaller current values for smaller fillets on thinner steel.

The appendix[2] to this paper is a set of specifications for arc welding steel buildings, and covers the following subjects;—general application, definitions, quality of structural steel and welding electrodes, welding apparatus, workmanship, qualifications of welders, proportion of parts, protection of steel. These specifications may be used by architects and engineers for incorporation into contracts for structural steel buildings with the assurance that the provisions have in general been successfully tried out on several steel structures.

2. See complete paper.

ILLUMINATION ITEMS

Submitted by
The Committee on Production and Application of Light

THE PRESENT STATUS OF LIGHT SOURCES AND WINDOW MATERIAL IN LIGHT THERAPY

By W. W. Coblentz

Judging by the general publicity by high-pressure advertisements and discussions regarding ultra violet radiation therapy it would appear that we are all growing rickety and, hence, should bask in the sun when it shines or use artificial sources of light as a substitute.

This whole business is built up on the general observation that common window glass shuts out short wavelength ultra violet solar rays which prevent rickets[1] and are beneficial for general therapeutic purposes, as for example, the treatment of tuberculous ulcerations, etc.

But there is some evidence that the pendulum has swung to the extreme, and that within a few years we shall be back to normalcy. Recent experiments by Russell[2] at the New Jersey Agricultural Experiment Station indicate that there is a holdover, so that a thorough exposure to ultra violet light (at least in chicks) will continue to be effective for a week or two. From this it would appear that it will not be necessary to take sunbaths or artificial light baths so frequently as formerly supposed.

Concerning the use of special window glasses for transmitting ultra violet solar radiation, biological and other data are forthcoming showing that the use of these glasses will be more restricted than had been hoped for by those interested. For example, the measurements of Dr. Janet Clark,[3] at the School of Hygiene and Public Health, Baltimore, show that a child seated at a distance of 16 ft. from a north window would have to remain there some 15 to 20 hours in order to get as much ultra violet radiation as it would receive in two minutes out of doors, in sunlight at the noon hour. Such findings will no doubt put a quietus on the advocacy of special glass windows on the north side of school and office buildings. Similar results were obtained by Dr. Walter Eddy,[4] at Columbia University, who found that in order to prevent rickets it was necessary to expose the animals to the direct path of the sun's rays. This is in agreement with the tests made by Tisdall and Brown,[5] and published a year earlier, showing that for really beneficial results it is necessary to use a solarium facing south, so that the nude body can be exposed to the direct rays of the sun.

Rapid improvement is being made in the production of special window glasses which do not decrease much in transmission as a result of solarization on exposure to the sun. Glasses are now available which, after solarization, transmit 50 per cent or more of the vitalizing ultra violet rays shut out by common window glass. The demand is for a glass that transmits 50 per cent or more of the ultra violet rays. The public is willing to pay the price. Different melts of the same kind of glass vary greatly in transmission, and it is incumbent upon the manufacturer to send out only the melts that have the highest transmission.

Fortunately for the public, competition will practically force the glass manufacturer to increase the transparency of the glass to be used in solariums, because the manufacturer of artificial sources of ultra violet radiation, particularly of carbon arc lamps, can claim a share of the trade on the basis that the spectral energy distribution is similar to that of sunlight. It is to be noted, however, that while the radiation from the carbon arc lamp is the nearest approach to sunlight, it is not the same as sunlight. In fact, it is far from it. By using a special "white flame" type of impregnated carbon electrode and a special window glass for a screen that absorbs the short ultra violet rays and the long infra red rays which are not present in sunlight, the spectral quality of the radiation from the carbon arc is rendered more nearly like that of sunlight. Such lamps are now on the market, and since the dosage can be controlled, and the light can be used at one's convenience, it is a strong competitor of window glass in light therapy.

Whether it is important to have a spectral energy distribution similar to sunlight remains to be determined. At any rate it makes a good talking point. It is to be noted, however, that good biologic results have been obtained with the quartz mercury arc lamp, in which the radiation is emitted in a few strong emission lines which in no way resemble the energy distribution in the spectrum of sunlight.

The wholesale use of such devices is so new, even to the average practitioner, that it is well to proceed with caution. The advertising slogan "consult your physician" should probably be qualified to mean one who has had actual experience in the administration of this "modality."

1. See recent tests by Bethke & Kennard, *Poultry Science*, 6, p. 290, 1927.
2. Russell, Massengale and Howard, *Jour. Biol. Chem.*, 80, p. 155; 1928.
3. Clark, *Science*, 68, p. 165, Aug. 17; 1928.
4. Eddy, *Science*, 68, p. XII, October 19, 1928.
5. Tisdall and Brown, *Amer. Jr. Diseases of Children*, 34, p. 742, November 1927.

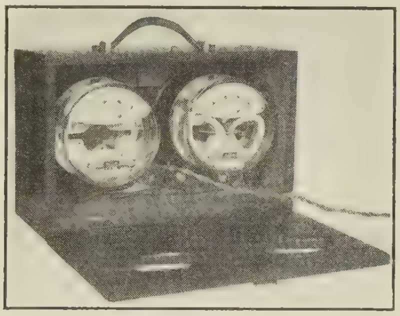
A DEVICE FOR MEASURING AVERAGE VOLTAGE

Particularly Adapted to Determination of Utilization Voltages

For some years, standards of illumination have been advancing steadily and will continue to do so as the value of good lighting becomes more and more generally recognized. In many cases the increased illumination is obtained by the simple expedient of putting higher wattage lamps in the old sockets without reinforcing the wiring to carry the additional load without excessive voltage drop. The unit cost of light (measured in terms of quantity received per dollar expended) will generally be increased by the under-

voltage burning that results from this increased voltage drop unless lamps of a lower voltage are used. The lighting service is rendered less uniform by excessive drop, because as the load increases or decreases, the voltage and consequently the light output per lamp will vary over a considerable range. During the period of heaviest use, when light is most in demand, the drop is greatest, the lamps are giving their lowest candle-power and the rate of loss is at a maximum. It is necessary, therefore, to know what the voltage conditions are in any plant or building, as a basis for obtaining the best possible service from the lighting installation.

This information can ordinarily be obtained by checking the voltage with indicating instruments, or by the use of curve-drawing voltmeters, tapped in right at the lamp. In the first case, however, considerable care must be used in selecting times of measurement and in estimating hours used. In the second case, the average voltage must be obtained by integration of a curve, and the equipment is rather expensive and requires careful handling and checking in order to obtain good results. To facilitate this sort of measurement, a new type of



Device for Measuring Average Voltage

(Mean square of average volts squared)

voltmeter has been tried out with very successful results. The instrument was constructed for use on a-c. circuits having fairly good frequency regulation.

The accompanying illustration shows the first attempt to produce an instrument of the kind desired. The box contains two standard watthour meter frames.

The one on the right is a kilowatt-hour meter which is standard in all respects except that it is built for a very small fixed load which is placed inside its own case. The current varies directly with the voltage, so that the wattage varies as the voltage squared and the readings of the instrument, therefore, are proportional to volts squared times hours. The gear train can be so chosen that if this meter is operated continuously at exactly 100 volts, its reading will correspond to the time in hours and tenths during which voltage was applied.

The second meter case (on the left) contains a synchronous clock motor, geared to the dials so that when supplied with 60-cycle current, it also reads hours and tenths directly.

The instrument is put in service by tapping it in to an extension plug inserted in the lamp socket, into which the lamp is screwed so that the voltage drop right up to the lamp terminals is taken into account. Both meters are read when the instrument is put in service.

After a period of time (say a day or two) both meters are read again. The differences of the readings show, for one meter, the hours the lamp was in use, and for the other, the hours times the volts squared. The second difference divided by the first gives the average of the volts squared. The square root of this figure then shows the square root of the average volts squared delivered at the socket during the time the lamp was actually burning. For the range of variation in operating voltage commonly encountered, the square root of the average volts squared will be practically the same as the average volts. As a matter of fact, as the light output and life of lamps both vary as powers of the voltage higher than the square, whatever departure there may be will increase the accuracy with which the average value of these quantities can be determined.

The process sounds complicated but it is really quite simple and gives results of a high order of accuracy. Undoubtedly the over-all dimensions and weight can be materially reduced as compared with those of the construction illustrated above. The instrument is accurate and not easily thrown out of adjustment. For use on d-c. circuits, the telechron could be replaced with a clock mechanism operated by a relay to record total hours in use, and a d-c. type of watt-hour meter would have to be used.

Every industrial plant and commercial building ought to check up, from time to time, the average voltage delivered at the lamp sockets to locate sections of the wiring system that need reinforcement or to determine what voltage of lamps should be used to correspond with that actually delivered at the sockets. A device of the kind described above will be found most useful for making such surveys.

A LIGHT AND SOUND SIGN

As part of its special Christmas decoration last year, one of the large Parisian Department Stores (Grands Magasins du Louvre) erected on the face of its building a large electric sign (about 160 ft. long and 80 ft. high) representing in colors a panoramic view of a fete on the River Seine. On the distant bank of the river, an impressive display of fire works was produced by flashing lamp effects, the appearance of the rockets, fountains, pinwheels, etc., being accompanied by realistic noises and explosions mechanically produced, and by smoke effects produced by steam. The cycle of operation required about twelve minutes, and then repeated. There were 15,000 lamps (ranging in size from 15 to 400 watts) used in the sign, which required nearly 50 miles of wiring and 35 motors for operating switches. The sign was made by the "Etablissements Jacopozzi."

Great crowds are said to have gathered every evening to watch the display.

Institute and Related Activities

Notice of Annual Meeting of Institute

The Annual Meeting of the American Institute of Electrical Engineers will be held in the New Ocean House, at Swampscott, Massachusetts, at 9.00 a. m. on Tuesday, June 25, 1929. This will constitute one session of the Annual Summer Convention, which is to be held in Swampscott, June 24-28.

At this meeting the annual report of the Board of Directors, also the report of the Committee of Tellers on the ballots cast for the election of officers will be presented.

Such other business, if any, as may properly come before an annual business meeting may be considered.

F. L. Hutchinson,
National Secretary.

Dallas Regional Meeting

A three-day Regional Meeting will be held under the auspices of the South West District of the Institute, with headquarters in the Adolphus Hotel, Dallas, Texas, May 7-9.

Four technical sessions are scheduled and also two Student Sessions, inspection trips, a lecture, a dinner-dance, etc. The technical papers deal with distribution systems, electrified oil-pipe lines, lightning, aviation lighting, telephony, radio program networks, waterworks and train signals.

The Student Sessions will be held on the afternoon of May 7 and the morning of May 8 respectively.

A complete program was published in the April issue of the Journal, page 319.

The Coming Summer Convention

EXCELLENT TECHNICAL PROGRAM AND DELIGHTFUL RECREATION PLANNED FOR MEETING AT SWAMPSCOTT, JUNE 24-28

A program crowded with pleasurable and profitable offerings is being arranged for the 1929 A. I. E. E. Summer Convention which will be held, with headquarters in the New Ocean House, at Swampscott, Mass., June 24 to June 28. All features which might make an enjoyable and worthwhile convention have been considered.

A selection of particularly high-grade technical papers has been made. These will deal with very live topics such as distribution systems synchronized at the load, automatic synchronizing, communication, electrical machinery, outdoor hydrogen-ventilated synchronous condensers, loading transformers according to temperature, shielding in electrical measurements, electrical heating elements, high-frequency electrical tools, etc.

Side View of the New Ocean House at Swampscott

Reviews of developments in all electrical fields will be presented in the annual reports of the Technical Committees of the Institute. The titles of the individual papers are given elsewhere in this announcement.

No locality is richer in opportunity for trips of engineering, scenic and historic interest. A large number of trips has been arranged.

For the recreational side of the program, a most enthusiastic local Convention Committee is planning many enjoyable events. Swampscott is an ideal place for a convention, combining seashore and country with excellent hotel facilities. Those who attended the 1923 Summer Convention at Swampscott remember the very enjoyable and successful meeting held at that time and it may be prophesied that the coming meeting will be equally as good.

Golf and tennis, a reception, a banquet, dancing and card playing will be some of the entertainment features. More information, particularly on the golf tournament, is given in later paragraphs.

The business side of the convention will include the Annual Meeting of the Institute, a report of the Committee of Tellers on election of officers for 1928-1929, the address of the President and presentation of prizes for papers.

The first Lamme Medal, which was awarded some months ago, will be presented to the medalist, Mr. A. B. Field of England.

There will be a lecture on the evening of June 25, by Dr. Harlowe Shapley; also several addresses at the banquet on June 26.

As customary at Summer Conventions, the first day will be devoted to conferences of Institute officers and delegates held under the auspices of the Committees on Sections and Branches. All members are invited to these conferences.

Reduced Railroad Rates

Reduced railroad rates on the certificate plan will be available for those attending the meeting from practically all points. By this plan the round trip will cost only one and a half times the one-way fare, provided 150 certificates are deposited at the Convention headquarters. These certificates must be obtained when visitors purchase their one-way tickets to Swampscott. Members of families are also entitled to obtain certificates. After 150 certificates have been deposited and the certificates have been validated, return tickets over the same route may be purchased for half the usual rate. There are certain restrictions regarding purchase dates, travel dates, etc., and local ticket agents should be consulted in every case.

OUTLINE OF CONVENTION PROGRAM

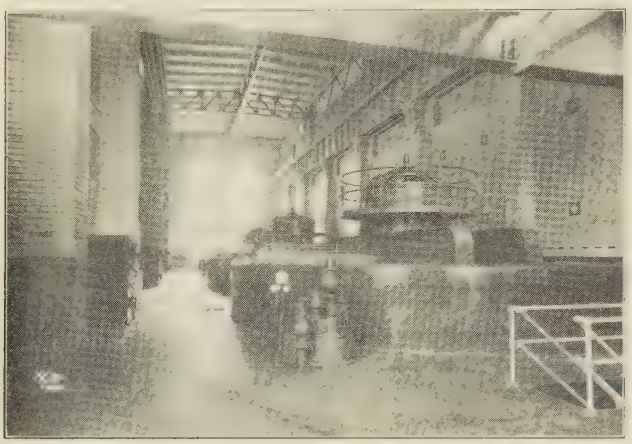
Monday, June 24

9:00 a. m.	Registration
10:00 a. m.	Conference of Officers and Section Delegates
12:30 a. m.	Section and Branch Delegates Luncheon
2:00 p. m.	Officers and Delegates Conference continued

2:00 p. m. Sports as scheduled; qualifying round for Mershon Cup
4:00 p. m. Branch Delegates Meeting
5:00 p. m. Afternoon tea
8:00 p. m. Informal dancing, cards

Tuesday, June 25

9:00 a. m. Registration
9:00 a. m. Annual Business Meeting
9:05 a. m. Address of Welcome—Gov. F. W. Allen
9:15 a. m. Report of Board of Directors (in abstract)



Interior of Bellows Falls Station of New England Power Association System

9:25 a. m. Report of Tellers; Introduction of, and response from, the President-Elect
9:35 a. m. Presentation of Prizes for Papers
9:45 a. m. President's Address
10:30 a. m. Two Technical Sessions, (a) Distribution and Power Plants; (b) Transportation
2:00 p. m. Trips as scheduled
2:00 p. m. Sports as scheduled. First round of matched play for Mershon Cup
5:00 p. m. Afternoon tea
8:00 p. m. Convention Lecture—Prof. Harlow Shapley of Harvard
9:15 p. m. President's Reception—dancing, cards

Wednesday, June 26

9:00 a. m. Social hour
9:30 a. m. Technical Committee Reports—2 Parallel sessions
2:00 p. m. Technical Session, (miscellaneous subjects)
2:00 p. m .Trips as scheduled
2:00 p. m. Sports as scheduled. Second (or third) round, Mershon Cup play; best nine holes out of 18
5:00 p. m. Afternoon tea
7:00 p. m. Convention Banquet
8:15 p. m. Presentation of Lamme Medal. Other banquet speakers
9:15 p. m. Entertainment, Mr. No Young Park, the Oriental Mark Twain. Music
10:30 p. m. Dancing, cards

Thursday, June 27—All-Day Trip to Rye Beach, Maine

9:00 a. m. Busses leave for trip along New England Coast to Rye Beach, Maine
9:30 a. m. Third round, Mershon Cup play
2:00 p. m. Final round, Mershon Cup play
5:00 p. m. Afternoon tea
6:30 p. m. Arrival from Rye Beach
8:30 p. m. Presentation of golf prizes, movies, dancing, cards

Friday, June 28

9:00 a. m. Social hour
9:30 a. m. Technical Sessions (a) Electrical Machinery, (b) Shielding in Electrical Measurements
2:00 p. m. Trips as scheduled
2:00 p. m. Sports as scheduled. Kickers' handicap
3:00 p. m. Start of Post-Convention Excursion through White Mountains
5:00 p. m. Afternoon tea
8:00 p. m. Informal dancing, cards

PAPERS FOR THE SUMMER CONVENTION

This list shows papers which are now proposed for this convention. Very probably one more paper will be added and possibly other changes will be made.

Distribution and Power Generation

Symposium on "Synchronized at the Load."

a. *Fundamental Plan*, A. H. Kehoe, United Electric Light & Power Co.

b. *Theoretical Calculations of System Behavior*, S. B. Griscom, Westinghouse Electric & Mfg. Co.

c. *System Tests and Operating Connections*, H. R. Searing and G. R. Milne, United Electric Light & Power Co.

Automatic Substations of Edison Electric Illuminating Co. of Boston, W. W. Edson, Edison Elec. Ill. Co. of Boston.

Rehabilitation and Rebuilding of Steam Power Plants, C. F. Hirshfeld, Detroit Edison Co.

Application of Induction Regulators on A-C. Distribution Networks, E. R. Wolfert and T. J. Brosnan, Westinghouse Electric & Mfg. Co.

Transportation

Electrification of the Mexican Railway, J. B. Cox, General Electric Co.

Contact-Wire Wear on Electric Railroads, I. T. Landhy, Illinois Central Railroad Co.

An Electrified Railroad Substation, J. V. B. Duer, Pennsylvania Railroad.

D-C. Railroad Substations, A. M. Garrett, Commonwealth Edison Co.

Miscellaneous

High-Frequency Portable Electric Tools, C. B. Coates, Chicago Pneumatic Tool Co.

Millbury-Medway Line Tie Between New England Power System and Boston Edison Company System

Electrical Wave Analyzers for Power and Telephone Systems, R. G. McCurdy and P. W. Blye, American Tel. & Tel. Co.

Telephone Transmission Reference Systems, W. H. Martin, American Tel. & Tel. Co.

Design of Electric Heating Elements, Edwin Fleischmann, The Niagara Falls Power Co.

Electrical Machinery

Safe Loading of Oil-Immersed Transformers, E. T. Norris of Ferranti, Limited.

Induction Motor Operation with Non-Sinusoidal Impressed Voltages, L. A. Doggett and E. R. Queer, Pennsylvania State College.

Outdoor Hydrogen-Ventilated Synchronous Condensers, R. W. Wieseman, General Electric Co.

Short-Circuit Torque in Synchronous Machines without Damper Windings, G. W. Penney, Westinghouse Elec. & Mfg. Co.

Analytical Determination of Magnetic Fields, B. L. Robertson and I. A. Terry, General Electric Co.

Hydrogen Cooled Rotary Condenser, Pawtucket Substation, New England Power Association System

Shielding in Electrical Measurements

Shielding and Guarding Electrical Measuring Apparatus, H. L. Curtis, Bureau of Standards.

Some Problems in Dielectric Loss Measurements, C. L. Dawes, P. L. Hoover and H. H. Reichard, Harvard University.

Shielding in High-Frequency Measurements, J. G. Ferguson, Bell Telephone Laboratories.

Shielding of Cables in Dielectric Loss Measurements, E. H. Salter, Elec. Testing Laboratories.

Precautions against Stray Magnetic Fields in Measurements with Large Alternating Currents, F. B. Silsbee, Bureau of Standards.

Magnetic Shielding in Electrical Measurements, S. L. Gokhale, General Electric Co.

Technical Committee Reports

About eighteen reports will be presented reviewing the major activities in the fields of the various Technical Committees of the Institute.

TRIPS

The trips which may be taken are given below. Two special trips are being featured, one an all day trip and outing to Rye Beach, Maine, and the other a post-convention tour through the White Mountains. The all day outing will be taken on Thursday, June 27, and will prove a most acceptable opportunity for making friends and enjoying the entertainment which will be provided. The post-convention tour will start on Friday afternoon, June 28, and will end at Greenfield, (Mass.) or Boston on Monday, July 3. The trip will be through New Hampshire, Maine and Massachusetts and will take in many beautiful lake and mountain scenes. The complete cost will be $48.50, with return to Greenfield, and $54, with return to Boston. This includes all transportation and hotels (double rooms). The following is a list of all trips:

All-Day Outing at Rye Beach, Maine (**June 27**)

Trips to Colleges

Massachusetts Institute of Technology, Cambridge
Harvard University, Cambridge

Historical Trips

Concord and Lexington, and Wayside Inn, Sudbury
Historical excursion of Metropolitan Boston
Salem—including Old Witch House, the House of Seven Gables, and Marblehead,
Plymouth

Trips to Power Plants, Substations, etc.

Edgar Station, E. E. I. Co. of Boston, North Weymouth
Montaup Station, Fall River, including Dupont Station and A-C. Network, Brockton
Automatic D-C. substation, E. E. I. Co. of Boston, Cambridge Street, Boston, and automatic substations of Boston Elevated Railway Company
Automatic A-C. Substation of the E. E. I. Co. of Boston, Arlington, and automatic substation of Malden Electric Company, Medford
Automatic telephone stations in Boston and suburbs
Trip to Dorchester Station of Boston Edison Company

Trips to Manufacturing Plants

General Electric Works, Lynn
Navy Yard, Charlestown; Dry Dock, South Boston; and Ship Yards, Quincy
Gillette Safety Razor Company, Boston
United Shoe Machinery Company, Beverly
Condit Electrical and Manufacturing Co., Hyde Park
Simplex Wire & Cable Company, Cambridge
First National Stores, Somerville
New North Station Refrigerating Plant & Gardens, Boston
Champion Lamp Works of General Electric Company, Lynn

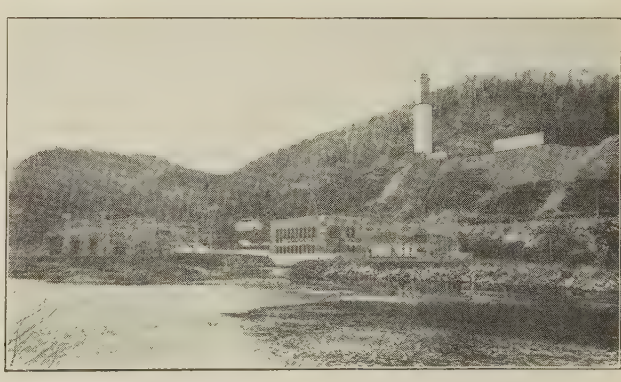
Other trips which may be arranged for special parties are:

Trip to College

Tufts College, Medford

Historical Trips

Boston Art Museum
Haverhill (Whittier's House)



Harriman Station of New England Power System
110-kv. and 66-kv. switch yards and surge tank

Trips to Power Plants, Substations, etc.

Electrification of Boston, Revere Beach, and Lynn R. R.
Service Buildings of E. E. I. Co. of Boston, Roxbury

Trips to Manufacturing Plants

Bethlehem Ship Building Yards, East Boston
Brown & Sharpe Company, Providence, R. I.
New England Confectionery Company, Cambridge
B. F. Sturtevant, Hyde Park
United Drug Company, Boston
Hood Rubber Company, Watertown

Hi-grade Lamp Company, Salem
Lever Bros., Cambridge
Naumkeag Mills, Salem
Watertown Arsenal, Watertown
Dennison Manufacturing Company, Framingham
Ford Assembling Plant, Somerville
Keith Shoe Company, Brockton

GOLF AND TENNIS

Both golf and tennis tournaments will be played on the excellent links and courts located near the hotel. The tournaments will be played for the respective Mershon Cups. It is proposed to present the prizes on Thursday evening and in order to accomplish this purpose all competition must be completed before Thursday evening. On account of the limited time and as the golf competition will be match play, the following information on the golf tournament is given:

The golf competition will consist of a qualification round (handicap medal play) of eighteen holes followed by match play (handicap).

The qualification round will be played on *Monday only*, June 24, 1929.

The sixteen low net scores will qualify for the match-play rounds.

No green fee will be charged members and registered guests. A representative of the Committee will be at the Club House at eight a. m. Monday, June 24, so that officers, section delegates, etc., who wish may play their qualification round early and still not miss their scheduled meetings.

In order to have as little interference as possible with business meetings and technical sessions, it is the wish of the Committee that play be restricted to the time of scheduled events, namely; Monday a. m. and p. m., Tuesday p. m., Wednesday p. m., and Thursday a. m. and p. m.

COMMITTEES

The 1929 Summer Convention Committee which is making the arrangements for the meeting consists of the following members who are officers of the committee or chairmen of other committees as indicated or general members: W. F. Dawson, *Chairman;* E. W. Davis, *Vice-Chairman*; H. B. Dwight, *Vice-Chairman*; C. S. Skoglund, *Vice-Chairman*; W. H. Colburn, *Secretary*; V. R. Holmgren, *Asst. Secretary*; H. P. Charlesworth, *Meetings and Papers*; W. B. Kouwenhoven, *Sections*; C. L. Edgar, *Finance*; C. A. Corney, *Trips*; F. S. Jones, *Transportation*; I. F. Kinnard, *Publicity*; W. E. Porter, *Hotel and Registration*; A. H. Sweetnam, *Sports*; Mrs. W. H. Timbie, *Ladies Committee*; J. P. Alexander, G. J. Crowdes, W. S. Edsall, S. J. Eynon, J. W. Kidder, R. G. Porter, W. H. Pratt, Ernest Shorrock, D. F. Smalley, H. B. Wood.

Fifth Session of International High-Tension Conference

June 6-15, 1929

The International Conference on High-Tension Systems, which was founded in 1921 under the auspices of the International Electrotechnical Commission will hold its fifth session in Paris, June 6th to 15th, inclusive. At the last session, 544 members coming from 28 countries took part, which shows the exceptional and world-wide interest in the proceedings of the Conference.

The coming session will give valuable opportunity for obtaining information regarding the technical progress of the last few years, together with the benefits to be derived from a personal touch with those working in other countries who have solved problems or who have, themselves, problems to solve. The proceedings will be carried on in English and French, with an interpreter present at each meeting to give every assistance required. As at the last conference, the French government will give its whole-hearted support.

Up to the date of this notice, 380 members from 21 countries have enrolled and 98 papers have been sent in from 18 different countries. The fee for the Conference is 250 fr. and in order to assist those planning to attend from abroad, the secretariat of the Conference offers any assistance possible to arrange in advance for accommodation in Paris to suit the convenience of all.

After the Conference the foreign committee in charge will arrange visits to installations of technical interest in the Pyrenees, the Alps, and the Riviera; it is hoped also to organize reunions with the Institution of Electrical Engineers of London for a summer meeting in Paris in June.

Address Organizing Secretary M. Tribot Laspière, 25 Boulevard Malesherbes, Paris or, for residents of the United States, Doctor C. O. Mailloux, 111 Fifth Avenue, New York.

Further Plans for Tokio

According to announcement made by Maurice Holland, Executive Secretary of the American Committee of the World Engineering Congress, (of which Doctor Elmer A. Sperry is Chairman), arrangements for the reception of 100 of Europe's most distinguished engineers and scientists who will arrive here during the summer enroute to Tokio have been placed in charge of Roy V. Wright, President of the United Engineering Societies, and Chairman of the New York Reception Committee. Mr. Wright will be aided by a committee of New York engineers which will plan inspection trips and arrange for our guests' entertainment and transportation while here.

It is expected that the foreign engineers will arrive in separate delegations of approximately forty each from Great Britain and Germany and the balance from Sweden, Denmark, France and Italy, probably during August and September.

The foreign delegation will sail from the Pacific Coast for Japan about the time that the American delegation, (now composed of 235 engineers and their families, from all parts of the country) sails from San Francisco. The American party has reserved a ship, and will embark at San Francisco October 11.

Serving with Mr. Wright on the New York Reception Committee are: Bancroft Gherardi, J. V. W. Reynders, F. R. Low, C. O. Mailloux, A. W. Berresford, H. Foster Bain, F. L. Hutchinson, Calvin W. Rice and George T. Seabury. Offices will be set aside for the visitors in the headquarters of the American Committee of the World Engineering Congress in the Engineering Societies Bldg., 29 West 39th Street.

The Exposition of Chemical Industries

The Twelfth Exposition of Chemical Industries, which opens May 6, 1929 at Grand Central Palace, New York, N. Y., bringing together most of the leaders in the chemical and allied industries in this country, will have over 450 exhibits of raw materials, chemicals, machinery, laboratory equipment, instruments of precision, etc., classified in the various sections. The exhibits of the various types of chemicals and machinery will permit the visiting engineer and executive to compare at first hand the various types of materials, equipment and chemical practises, with many new features exhibited for the first time.

Of particular interest to chemistry teachers will be the conferences on Tuesday, Thursday and Friday afternoons. It is expected that a number of professors will be present at these discussions to express opinions on the teaching of chemistry.

Reactive Power

A "Questionnaire on the Problem of Reactive Power" has been prepared by Prof. C. Busila, of the National Roumanian Institute for the Study of the Development and Utilization of Sources of Energy, for the Advisory Committee on Improvement of Power Factor, of the International Conference on Large High-Voltage Systems. At the direction of the Standards Committee of the Institute, an English edition has been published. This has had wide distribution both in this country and abroad.

A limited number of copies is still available and may be obtained by addressing H. E. Farrer, Secretary, Standards Committee A. I. E. E., 33 West 39th St., New York, N. Y.

The great importance of the questionnaire, representing as it does the most complete presentation thus far made of the various questions raised in regard to "power-factor and its improvement," renders it worthy of the most extensive consideration and publicity. Upon its reference to the Electrophysics Committee of the Institute, a sub-group of that committee was formed under the chairmanship of Dean O. J. Ferguson of the University of Nebraska to carefully study the questionnaire. This sub-group has asked that contributions be made upon the following points:

I. Acceptable definitions for reactive power under each of the following conditions:

1. Single-phase circuits, non-sinusoidal waves.
2. Polyphase circuits.
   - (A) Sinusoidal waves, unbalanced circuit.
   - (B) Non-sinusoidal waves.
     - (a) Balanced circuit.
     - (b) Unbalanced circuit.

II. Establishment of practical methods for the measurement of reactive power in each of the above cases.

III. Analysis of present reactive-power clauses in contracts, and establishment of a practical and fair basis for rate-making.

In approaching this problem, we recognize that we can limit ourselves to theoretically correct bases only in so far as these are capable of giving practicable methods,—*i. e.*, comfortable practise, without too great complexity or abstruseness. Rather than wander into involved conditions, we may have to make empirical and arbitrary agreements which will meet the further needs of practise. Rate-research committees, public service commissions, manufacturers, operators, consumers, laboratory investigators, research men; all these must be satisfied that our proposals are not inimical to their interests, but are usable with a fair degree of justice, comfort and simplicity and that the range of usefulness is recognized.

To whatever extent it is possible, new terms and multiplicity of methods must be avoided.

The subcommittee will be glad to have your constructive proposals upon certain points sent in duplicate to its secretary, Doctor M. G. Malti, Franklin Hall, Cornell University, Ithaca, N. Y.

1. Are all the important objectives included in the outline I have presented above? Are the statements sound?

2. Shall the study be directed by the Roumanian questionnaire, or shall a base be established along some such lines as above?

3. What direction of approach will be most effective,—theory or practise?

AMERICAN ENGINEERING COUNCIL

CONFERENCE OF ENGINEERING SECRETARIES TO BE HELD IN CHICAGO, JUNE 6-7, 1929

The call for the Fourth Conference of Secretaries of Engineering and Allied Technical Organizations has been issued by Mr. L. W. Wallace Executive Secretary of American Engineering Council, 26 Jackson Place, Washington, D. C.

The meetings will be held in the rooms of the Western Society of Engineers, 205 W. Wacker Drive, Chicago, Ill., as guests of the Society.

The invitation was issued from the headquarters of American Engineering Council, April 4.

A. S. C. E. JOINS COUNCIL

With the approval of Council Delegates, the American Society of Civil Engineers, with headquarters at 33 West 39th Street, New York, N. Y., has been admitted to membership in American Engineering Council. The American Society of Civil Engineers was organized in 1852 and has a membership as of January 1, 1929, of 13,577 professional engineers.

The application was submitted April 3, 1929, in accordance with authorization of its Board of Direction, given on January 15, 1929 and the delegates thus far selected by the A. S. C. E. are;

For the term ending January 1, 1930; Baxter L. Brown, St. Louis, Mo.; L. L. Calvert, Philadelphia, Pa.; A. J. Dyer, Nashville, Tenn.; George T. Seabury, New York; C. E. Grunsky, San Francisco, Calif.; and Frank N. Gunby, Boston, Mass.

For the term ending January 1, 1931: H. S. Crocker, Denver, Colo.; A. J. Hammond, Evanston, Ill.; John C. Hoyt, Washington, D. C.; Anson Marston, Ames, Iowa; Francis Lee Stuart, New York, N.Y.; and Frank M. Williams, Albany, N. Y.

STREET TRAFFIC REPORT DISTRIBUTION PROGRESSING

The initial supply of 10,000 copies of American Engineering Council's Report on Street Traffic Signs, Signals and Markings is nearing exhaustion with the distribution which was begun the first of February, 1929. Through their local sections, all of the national engineering societies are cooperating in bringing this report to the attention of the municipal authorities throughout the country, American Society of Civil Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers having done especially active work in this regard.

The distribution of this report brings very forcibly to the attention of American Engineering Council the need for established engineering agencies in each state in the Union, in order that such matters may come to the attention not only of engineers, but the general public. Some states are cared for by state engineering societies; others have state engineering councils organized in much the same manner as American Engineering Council. Organizations in the following twenty states have definitely accepted responsibility for sponsoring the presentation of the traffic report in their respective states; Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Oklahoma, Pennsylvania, Rhode Island, Tennessee, Virginia, Wisconsin and Wyoming.

Arkansas, Arizona, Colorado, Idaho, Montana, Nebraska, Nevada, New Mexico, North Carolina, North Dakota, Oregon, South Dakota, Texas, Utah, Vermont, and Washington have organizations which have been approached to handle the distribution of the report, but have not as yet reported what action has been taken, and there are twelve additional states in which agencies are yet to be selected for this public service.

In addition to American Engineering Council, two other national agencies have performed excellent service in the distribution of this report. The U. S. Chamber of Commerce, under the direction of Col. A. B. Barber, has distributed over 3500 copies through the various chambers of commerce, and the American Automobile Association, under Ernest Smith, has distributed approximately 1500 copies. Both the U. S. Chamber of Commerce and the American Automobile Association were participating agencies in the preparation of this report.

ENGINEERS IN PUBLIC LIFE

A recent canvass by American Engineering Council of governors of all states, and members of the Senate and House of Representatives discloses many engineers holding responsible positions in the political life of the nation.

Those listed are divided into three classes,—those who are, or were at the time of their election to public office, professional engineers both by training and experience; those who have been engaged in work which is essentially engineering and which requires the engineering mode of thinking and method of approach; and those who have received their basic training and education in engineering with a B. S. degree in an engineering school, but subsequently developed fields of other activity.

The governors who are professional engineers are Clayton D. Buck of Delaware, George H. Dern of Utah, F. C. Emerson of Wyoming, Morgan F. Larson of New Jersey, and George A. Parks of Alaska.

Governor John H. Trumbull of Connecticut has received no engineering degree, but has been engaged in the manufacture of electrical machinery, having been President of the Trumbull Electric and Manufacturing Company, Chairman of the Board of Colonial Air Transport Company, Director of the Hartford Steam Boiler Inspection Company and similar enterprises. Governor Bibbs Graves of Alabama, although a lawyer, received his first degree as a Batchelor of Civil Engineering, University of Alabama. Governor O. M. Gardner of North Carolina, was a student at the State College of Agriculture and Engineering and received Bachelor of Science degree from the University of North Carolina. Governor Harry S. Leslie of Indiana, received the degree of Batchelor of Science from University of Purdue.

Two recent and well-known ex-governors are professional engineers: James G. Scrugham of Nevada and James Hartness of Vermont, Past-President of American Engineering Council.

The above names show a decidedly increasing tendency of the public to trust men of engineering training with public office. In 1920 there were but two governors of states who could be placed in one of these three classes; in 1910 also there were but two.

In the U. S. Senate of the 70th Congress there were five men with engineering training and experience: Vice-President Charles Dawes, who served as a major of the 17th Engineers, U. S. A., was in the Engineer Corps during most of his experience in the World War, and is Past-President of the American Society of Military Engineers; Senator R. B. Howell of Nebraska is a civil engineer, a graduate of the U. S. Naval Academy, and at one time City Engineer of Omaha and State Engineer of Nebraska; Senator H. W. Keyes of New Hampshire, although a lawyer, received the B. S. degree from New Hampshire College; Senator Tasker L. Oddie of Nevada, is a member of the A. I. M. & M. E. Senator Millard E. Tydings of Maryland is a graduate of the Maryland Agricultural and Mechanical College in the School of Mechanical Engineering. This shows a decided increase in the number of men in public office who have engineering experience. In 1920 the Senate had but two men who could be placed in these classifications, and in 1910, there were but three.

The House of Representatives does not show such a marked increase of membership of those who have engineering training and experience. Nevertheless, there has been a steady increase since 1910. In 1910 it included three professional engineers and three members with engineering experience. Also, three with Bachelor of Science degrees. The House of Representatives in 1920 contained two men with engineering experience and thirteen who had received B. S. degrees.

The House of Representatives of the 70th Congress, 1929, contained a total of 21 members with engineering training or experience.

Five Engineers who may be classed as professional engineers are in Congress, They are:

L. W. Douglas of Arizona, who studied mining and metallurgical engineering at M. I. T. and has six years of mining experience. H. L. Englebright of California, who graduated in mining engineering at the University of California. S. S. Arentz of Nevada, who is a mining engineer and graduated from the South Dakota Schools of Mines. (Past-President of the Utah Society of Engineers) Ernest R. Ackerman of New Jersey has been a member of the N. J. Geological Survey. J. T. Deal of Virginia is a civil engineer and a graduate of Virginia Military Institute.

Members of the House of Representatives, 70th Congress who have had some engineering experience are, Paul J. Moore of New Jersey, Wm. L. Carss of Minnesota, John McSweeney of Ohio, Franklin Menges of Pennsylvania, and Louis Monast of Rhode Island.

Those who have had training in some engineering institution and in most cases have received B. S. degrees from an engineerng college are: R. A. Green of Florida, L. J. Dickinson of Iowa, W. B. Gregory of Kentucky, David Kincheloe of Kentucky, W. P. Martin of Louisiana, W. P. Cole of Maryland, Jess Bushby of Mississippi, F. N. Hale of New Hampshire, A. J. Griffin of New York, George C. Peery of Virginia and E. T. England of West Virginia.

STATES INTERESTED IN WATER RESOURCES

There is a movement on foot among the various States of the Union to create an agency or empower an existing agency with authority to act in all matters appertaining to the water resources of the particular state. A number of legislatures are considering measures of this character.

One of the first states to pass such a measure is the State of North Carolina, the act as passed being a combination of House Bill 1149 and Senate Bill 1403, entitled, "An Act Providing for Administration and Control Over Interstate Waters."

The John Fritz Medal Presented to Mr. Hoover

At a luncheon given by Mr. Hoover to present and past members of the Board of Award, preceding medalists, and presidents and secretaries of the American Societies of Civil, Mining and Metallurgical, Mechanical and Electrical Engineers the John Fritz Gold Medal for 1929 was presented to President Herbert Hoover at the Executive Mansion, Washington, Thursday, 25th April.

This medal is the highest honor bestowed jointly by the four national engineering societies, whose membership is 60,000. It is awarded annually for "notable scientific or industrial achievement, without restriction on account of nationality or sex." In accordance with custom, the award to Mr. Hoover was made tentatively and without announcement in October 1927 and was formally confirmed and announced one year later.

At the presentation, Dean Dexter S. Kimball, of Cornell University, Chairman of the present Board of Award, presided and gave a brief history of the medal. General John J. Carty, Past-President, American Institute of Electrical Engineers, and former member of the Board of Award, spoke briefly of the human elements of Mr. Hoover's life work. Dr. John R. Freeman, Past-President of the American Society of Mechanical Engineers and of the American Society of Civil Engineers, and a former member of the Board of Award, spoke of Mr. Hoover's work as an engineer; and Mr. J. V. W. Reynders, Past-President of the American Institute of Mining and Metallurgical Engineers and Chairman of the Board which made the award to Mr. Hoover, presented the medal, with the accompanying certificate, which read in part: "To Herbert Hoover, engineer, scholar, organizer of relief to war stricken peoples, public servant." Mr. Hoover responded with a brief address expressing his high appreciation of the honor conferred by the award of the medal.

The luncheon which followed the presentation ceremonies was attended by President and Mrs. Hoover and the delegation of forty-two engineers. The A. I. E. E. delegation included President Schuchardt, National Secretary Hutchinson and the following eighteen Past-presidents: Messrs. Adams, Arnold, Berresford, Buck, Carty, Chesney, Dunn, Ferguson, Gherardi, Jackson, Jewett, Kennelly, Mailloux, McClellan, Osgood, Rice, Jr., Scott, and Stillwell.

International Congress on Steel Construction

In connection with the international exposition of leading industries at Liege, Belgium in 1930, the sciences and their application, and ancient walloon art will be reviewed by American engineers, steel manufacturers and others interested, who are invited to participate in an International Congress of Steel Construction in Liege, Belgium, and to present papers or to

contribute to the discussions. Suggestions for the program, if sent soon, will be welcomed. Intention to participate should be made known promptly so that future bulletins may be sent to persons interested. The Organizing Committee appeals to foreign specialists to send papers on problems which they have studied, besides becoming members of the Congress. Each national committee is requested to designate a reporter for each division of the general subject, this reporter to summarize the contributions from his country and to send the papers and reports to the Executive Committee in Belgium. A general reporter for each division will later be appointed to correlate all information for the Congress and start discussion. Papers will be furnished in advance copy form and the Executive Committee would therefor, like to receive the papers and reports by September 1929 to insure printing and distribution well in advance. The four days of the congress will be between August 15 and September 15, 1930. The official languages will be English, French and German; papers to be published in their original languages with summaries probably in all three languages.

In order to receive preliminary publications of the Congress, the fee of 35 belgas (approximately $5) should be sent to Congres International de la Construction Metallique, 4 Place Saint Lambert, Liege, Belgium, together with registration as follows:

(Full name)..

(Profession or business)..............................

(Full address)..

registers for the Industrial Congress of Steel Construction at Liege in 1930.

He intends to participate in the activities of the Congress..............................

He is especially interested in the following subject:..............................

Date.............................. Signature..............................

A rooming service will be organized. There will be interesting excursions and social features. Ladies are invited and their visit will be made enjoyable.

Americans are urged to collaborate because of their notable achievements in structural steel.

Cincinnati Holds Regional Meeting

The fifth Regional Meeting of the Middle Eastern District of the Institute was held in Cincinnati, Ohio, with headquarters at the Hotel Gibson, on March 20-23. About 270 were registered for the meeting. Four technical sessions were held at which 17 papers were presented. A report of these sessions is given below. A Student Activities session was another feature, and there were several inspection trips and a convention dinner.

At the Student Activity Session there were three addresses as given below, and a number of short reports by Branch representatives. The addresses were as follows: *The Student Branch as a Part of the Institute Organization*, by H. H. Henline; *The Student Convention, Its Purposes and Procedure*, by Morland King, and *Report on Work of Student Branches*, by L. A. Doggett. Fifteen Students then presented two-minute reports of the activities of their respective Branches. This part of the program was announced as a competition and prizes were awarded later for the reports which were considered best as follows: A first prize of $10 to R. B. McIntosh, Case School of Applied Science, and a second prize of $5 to C. C. Coulter, West Virginia University.

In addition to this meeting the Students and Branch Counselors attended luncheons on March 20 and 21. Great interest was shown in the meeting by the Students of whom 57 were registered. More information on the discussion at the luncheons is published in this issue of the JOURNAL under "Student Activities."

In the opening session on March 20, J. L. Beaver, Vice-President of the Institute in the Middle Eastern District, made a short address. He was followed by Charles Eisen, President Pro-tem of the Cincinnati Council who delivered a short speech of welcome.

At the convention dinner held on the evening of March 21 both President R. F. Schuchardt and Vice-President J. L. Beaver spoke. Then C. M. Newcomb talked very interestingly on the subject "What Are You Afraid Of?" Prof. A. M. Wilson presided at the dinner.

Several inspection trips were scheduled to power and industrial plants.

A unique demonstration which attracted wide attention was made on the first evening of the meeting. On this evening an airplane flew over the city and when directly above the Hotel Gibson, the letters "A. I. E. E." appeared in lights on the bottom side of the plane's wings. An instant later by means of a radio impulse sent by the pilot from the plane, a set of floodlights on the hotel was switched on, thus suddenly illuminating a large fountain in front of the hotel.

Report of Discussion

The following paragraphs give a summarized report of the discussion at the technical sessions. The papers presented at each session are listed and are followed by an account of the main points covered by the discussors. The complete discussion will be published in the TRANSACTIONS immediately following the respective papers:

GENERAL SESSION

Recent Developments in Telephone Construction Practises, by B. S. Wagner and A. C. Burroway.

Illumination of Airports and Airways, by H. E. Mahan.

Iron Losses in Turbine Generators, by C. M. Laffoon and J. E. Calvert.

In connection with the paper on telephone construction, C. A. Jaques asked if damage to cable sheaths is likely to result from forcing gas at 40 lb. pressure into the cable. Mr. Wagner replied that any pressure below 50 lb. may be used with safety.

After presenting his paper Mr. Mahan was asked about the suitability of the arc lamp and the neon lamp for airport lighting. He stated that illumination from the arc lamp is quite satisfactory but that it has the disadvantage of requiring a man to operate it. He said that although the neon lamp has been advocated as especially efficient in piercing fog, recent tests have shown that it is not better than the incandescent lamp in this respect.

In discussing the third paper, L. A. Doggett asked if there are any experimental data which confirm the theories presented. Mr. Calvert said he had obtained very little experimental confirmation, though it is possible to get such data by very tedious methods.

AUTOMATIC STATIONS AND WELDING SESSION

Street Railway Power Economics, by J. A. Noertker.

Automatic Mercury Arc Rectifier Substations in Chicago, by A. M. Garrett.

Arc Welding of Steel Buildings and Bridges, by F. P. McKibben.

Fabrication of Large Rotating Machinery, by H. V. Putman.

T. H. Schoepf, discussing Mr. Noertker's paper, said he believed that the fixed charges of 12 and 15 per cent respectively, as advocated in the paper, are too high. He claimed also that a charge of 2 per cent for taxes may not be correct as taxes are fixed rather arbitrarily by local boards. J. C. Bailey questioned the choice of 1000-kw. converters instead of 750-kw. machines as the smaller machines would operate at higher load (75 per cent of rated load) and thus at a more efficient point. He stated that his company has found the d-c. type of control for automatic stations superior to the a-c. type. In answer to Mr. Schoepf, Mr. Noertker explained that his figures for return on the investment include 2 per cent margin because the franchise of his company limits the return to 6 per cent. In replying to Mr. Bailey he stated that there were two reasons why the 1000-kw. converters were chosen, (1) the 750-kw. converter is a faster ma-

chine (1200 rev. per min.) and is subject to higher maintenance costs, and (2) the 1000-kw. machines were placed in outlying territories where a growth of load is expected which could not be carried by the 750-kw. machines.

In commenting on Mr. Garrett's paper, Otto Naef pointed out the trend of substituting a large number of small automatic substations for a small number of large stations. J. G. Swallow stated that on the Illinois Central System there has resulted a gain in efficiency of 17 per cent on a capacity factor of 12 per cent when rectifiers were substituted for rotating converters. Mr. Garrett said that in his experience the gain in efficiency is great if the machine operates at low loads. In answer to a question by J. A. Noertker, he said that if a tank is opened only for inspection or cleaning the mercury the rectifier can be put back into operation in a very short time. If a new anode or insulator is needed considerable time is required to make the change and to season the machine before again putting it into operation; sometimes as much as 75 or 100 hr. being required.

In answer to several questions on his paper Prof. McKibben stated that visual inspection is the only inspection applied to riveted joints in structural work. He explained that dependence is placed largely on the ability of the welders who must pass very thorough tests before they are employed. He stated that welds made by the electric arc and the oxy-acetylene flame have the same strength. Atomic-hydrogen arc welding he said makes a denser weld with slightly higher elastic limit but no greater tensile strength. The atomic-hydrogen process he stated is not applicable to a building. He stated that many shops build up worn parts of machines by welding, such as flanges, shafts, etc. On this point H. V. Putman said that his company does not permit welding on shafts as residual stresses are produced which may cause failure under vibratory forces.

In answer to questions on his paper Mr. Putman explained that the increased permeability of welded machine frames is not a factor in the reduction of weight. He said that welded construction of machine spokes has eliminated the necessity for blowers on low-speed machines, while the windage loss is about the same.

High-Speed Instruments and Measurements Session

High-Speed Photography in Electrical Engineering, by H. W. Tenney.

Oscillographs for Recording Transient Phenomena, by W. A. Marrison.

A New Type of Hot-Cathode Oscillograph, by R. A. George.

Bushing-Type Current Transformers for Metering, by A. Boyajian and W. F. Skeats.

Excitation of Current Transformers under Transient Conditions, by D. E. Marshall and P. O. Langguth.

Morton Sultzer showed and explained a number of oscillograms taken with the instruments described in Mr. Marrison's paper.

In answer to several questions by W. L. Everitt, Mr. George said that if the filament in his oscillograph were sealed in a tube, a long life would probably result. At present he said the life has not been long though it has sometimes run to 30 or 40 hr. The principal trouble he said has been caused by light oil vapors from the vacuum pump which apparently reduce the oxide on the filament. He stated that there is not any appreciable dispersion of the beam at pressures less than 10 or 15 microns. He explained that for moving the film from outside the tube a rod is used which passes through a joint packed with cotton covered with heavy grease.

In discussing the paper on current transformers, C. T. Weller claimed that the accuracy of the modified method described is inferior to that of the standard two-stage method. Mr. Boyajian stated that this is not true if the "auxiliary impedance" is made of the correct value. A. M. Wiggins suggested that by using high-grade core material such as hypernik, good results might be obtained without the complicated design described by Messrs. Boyajian and Skeats. Mr. Boyajian agreed with this but claimed that with a given material the two-stage transformer will give greater accuracy than the single-stage.

Power Systems Session

Electrical Equipment of Bar Plate and Hot Strip Mills, by J. B. Ink.

Fused Arcing Horns and Grading Rings, by P. B. Stewart.

Operating Experience with the Low-Voltage A-C. Network in Cincinnati, F. E. Pinckard.

Quick-response Generator Voltage Regulator, by E. J. Burnham. J. R. North and I. R. Dohr.

Cathode Ray Investigation of Transmission Lines with Artificial Lightning, by K. B. McEachron.

In connection with Mr. Stewart's paper, R. L. McCoy said that laboratory tests indicate that the fused arcing horns will be suitable for 110- and 132-kv. lines. S. M. Hamill, Jr., emphasized the rapidity of the fuse's action which is quicker than the fastest relay setting of about 9 cycles. C. L. Fortescue stated that his company is attempting to achieve similar results by incorporating into an insulator string the properties of a lightning arrester. O. S. Clark stated that tests have shown that there is only a remote possibility that both fuses in the arrangement will blow at the same time. H. C. Don Carlos asked if conditions warrant the expense of installing these rings and fuses. His company he said operates without any grading rings and has practically no outages caused by lightning. Mr. Stewart pointed out that lightning is more frequent on his own company's lines and that two and three parallel circuits sometimes flashover at the same time.

F. C. Hanker, in discussing the paper by Messrs. Burnham, North and Dohr, stated that there are two ways of handling large loads placed suddenly on a system, (1) by using machines having suitable inherent regulation and (2) by using a quick-response regulator as described in the paper. R. M. Carothers pointed out that the vibrating type regulator also can be arranged for quick response. Mr. Burnham in answer to a question stated that special light contactors are used in the regulator.

C. L. Fortescue, in connection with the last paper outlined some artificial lightning tests which his company is making on a 220-kv. line now under construction. In these tests he hopes to obtain valuable data on the impedance of tower footings. Such tests, he stated, are much preferable to tests on small-scale models. A. M. Opsahl described in more detail the tests on the 220-kv. line mentioned by Mr. Fortescue. W. L. Everitt suggested that the effects of transients on transmission lines might be predicted by analyzing the lines in terms of bands of frequencies as is done on communication lines. In answer to a question Mr. McEachron stated that in his tests the disturbing effect of the capacity of the cathode ray oscillograph is about equal to that of a string of insulators.

Nation-Wide Radio Hook-Up on Safety

In cooperation with the National Safety Council, the National Broadcasting Company announces definite dates for five of the thirteen speakers who will deliver weekly radio addresses in connection with the "Universal Safety Series," which began April 20, with an initial speech by Charles M. Schwab, Chairman of the Board, Bethlehem Steel Company, on "Safety a Factor in Industry" prefaced by a few introductory remarks by Henry A. Renlinger, president of the National Safety Council. On May fourth program has scheduled as its speaker P. R. Crowley, President of the New York Central Railroad and the weekly programs from then on will include such men as Col. Robert P. Lamont, Secretary of Commerce ("Safety—a National Problem"); Doctor Miller McClintock, Director of the Albert Russell Erskine Bureau of Street Traffic Research, Harvard University ("Making our Highways Safe"); Mr. Grover A. Whalen, Police Commissioner of New York City ("Enforcement as an Aid to Safety"); J. E. Sheedy, Executive Vice-President of

the United States Lines, New York City, ("Safety on the High Seas") and the Honorable James J. Davis, Secretary of Labor ("Safety of the Worker"). Four additional subjects will be, "Education—the part it plays in Safety," "The Automobile and Safety," "Safety in the Air" and "Summing Up." Already 26 stations are included in this hook-up and there are others to join if a rearrangement of their present schedules will permit.

A. I. E. E. Directors Meeting

The regular meeting of the Board of Directors of the American Institute of Electrical Engineers was held at the Hotel Gibson, Cincinnati, Ohio, on Thursday, March 21, 1929, during the Cincinnati Regional Meeting of the Institute.

There were present: President R. F. Schuchardt, Chicago, Ill.; Vice-Presidents O. J. Ferguson, Lincoln, Neb.; J. L. Beaver, Bethlehem, Pa.; A. B. Cooper, Toronto, Ont.; C. O. Bickelhaupt, Atlanta, Ga.; W. T. Ryan, Minneapolis, Minn.; Directors E. C. Stone, Pittsburgh, Pa.; C. E. Stephens, New York, N. Y.; H. C. Don Carlos, Toronto, Ont.; F. J. Chesterman, Pittsburgh, Pa.; F. C. Hanker, East Pittsburgh, Pa.; E. B. Meyer, Newark, N. J.; J. Allen Johnson, Niagara Falls, N. Y.; A. M. MacCutcheon, Cleveland, Ohio; National Secretary, F. L. Hutchinson, New York, N. Y. By invitation, Professor Harold B. Smith, presidential nominee, Worcester, Mass.

The minutes of the Directors meeting of January 30, 1929, were approved.

Approval by the Finance Committee, for payment, of monthly bills amounting to $24,174.99, was ratified.

Upon the committee's own recommendation, the Finance Committee was authorized to invest at this time, $10,000 now available of the sum set aside in the budget for the Reserve Capital Fund.

The Board ratified the action of the Executive Committee, under date of March 11, on pending applications, as follows: 207 applicants were admitted to the grade of Associate; 14 applicants were elected to the grade of Member; 11 applicants were transferred to the grade of Member; six applicants were transferred to the grade of Fellow; 349 Students were enrolled.

Reports were presented of meetings of the Board of Examiners held February 20 and March 6, and the actions taken at those meetings were approved.

In accordance with the request of the District officers, approval was given to holding the already authorized Louisville Regional Meeting during the week of November 17-21, 1930.

Upon the recommendation of the Chairman of the Sections Committee, authorization was given for the organization of a North Carolina Section of the Institute.

Consideration was given to three communications from the Standards Committee, and in accordance with the recommendations contained therein the following actions were taken:

Approved for adoption as an Institute Standard and for submission to the American Standards Association, the standard for Four-pin Vacuum Tube Bases, developed by the Sectional Committee on Radio, for which the Institute is joint sponsor with the Institute of Radio Engineers;

Approved action of Standards Committee in declining an invitation to appoint a representative on the Sectional Committee on Standardization and Unification of Screw Threads, issued by the American Society of Mechanical Engineers, co-sponsor with the Society of Automotive Engineers for this project;

Approved the deletion of Rule 16000 (Standards for Heating Devices) of 1922 edition of the A. I. E. E. Standards, which has never been replaced in the general work of revision of the Standards; this action being taken because the rule "provides, in the opinion of the Standards Committee, for a test of such a low value under present conditions that if put into use, it might cause considerable trouble."

Mr. L. A. Ferguson was reappointed a representative of the Institute on the Commission of Washington Award, for the two-year term beginning June 1, 1929; and Mr. F. W. Peek was nominated, for appointment by the President of the National Academy of Sciences, as a representative of the Institute on the Division of Engineering and Industrial Research of the National Research Council, for the term of three years beginning July 1, 1929, to succeed Mr. Cary T. Hutchinson, whose term expires at that time and who is ineligible for immediate reappointment.

The Board confirmed the appointment by the President of the following Tellers Committee to canvass and report upon the votes cast by the membership for the 1929 election of Institute officers: Messrs. W. E. Coover (Chairman), W. C. F. Farnell, Alek Johnson, R. R. Kime, E. J. O'Connell, R. A. Rich, and John T. Wells.

In acceptance of an invitation from the American Society of Civil Engineers to designate an Institute member to serve on a committee to make recommendations to the A. S. C. E. Board of Direction in regard to the award of the Alfred Noble Prize, it was voted to appoint, each year, the Chairman of the A. I. E. E. Committee on Award of Institute Prizes for the past year.

Consideration was given to a request from the American Committee of the World Engineering Congress, Tokio, October 1929, to designate, from the list of prospective members of the American party prepared by the office of the American Committee, seven official delegates of the Institute to this Congress. It was voted that the President and the National Secretary be appointed as two of the seven, and that the President name the remaining five delegates.

Other matters were discussed, reference to which may be found in this and future issues of the JOURNAL.

Annual Report of Engineering Societies Library

The following is an abstract of the Annual Report of the Library Board to the United Engineering Society and to the Founder Societies for the year 1928 presented at the annual meeting of the Library Board on January 10, 1929.

During the year, the recorded visitors numbered 23,470 not including over 5000 requests for information by telephone. Searches and translations were 202 and 221, respectively, while 3637 individuals were supplied with photoprints. By various methods, a total of 37,000 members was served. The main collection totals over 130,000 volumes, pamphlets, maps, etc., including about 8300 additions during the year. The record of the rental collection shows 317 members borrowed books. Receipts from the sale of books from the duplicate collection amounted to $1062.83.

A study by the Trustees of operating cost resulted in the recommendation to the Founder Societies of a distribution by which the expense is partially shared upon a per capita basis. This method was approved by the Founders.

The amount appropriated for operating expense for the year was $46,300. The operating cost was $45,584.10. The Service Bureau met its expenses from its receipts.

The complete report in pamphlet form may be obtained by addressing Harrison W. Craver, Director, Engineering Societies Library, 33 West 39th Street, New York, N. Y.

1929 Officers of Eye Sight Convervation Council of America

Lawrence W. Wallace has been re-elected president of the Eye Sight Conservation Council of America, which is conducting a nationwide movement for better vision in industry and education. Mr. Wallace is Executive Secretary of the American Engineering Council, and a Past-President of the Society of Industrial Engineers. Other officers for 1929 have been chosen as follows: Vice-President, Bailey B. Burritt, New York;

General Director, Guy A. Henry, New York; Treasurer, William R. Wall, New York. James J. Davis, Secretary of Labor, was named a member of the Board of Councilors. The following were also elected to the Board: Dr. Arthur L. Day, Director of the Geophysical Laboratories of the Carnegie Institution of Washington; Prof. Charles H. Judd, Director of the School of Education, University of Chicago; Dr. Frederick B. Robinson, President of the College of the City of New York; Prof. Joseph W. Roe, head of Industrial Engineering Department of New York University, G. E. Sanford, Schenectady, New York, past president of the American Society of Safety Engineers; Richard E. Simpson, Associate of the Institute and research engineer of Hartford, Conn.; Dr. John J. Tigert, former U. S. Commissioner of Education; Dr. Thomas D. Wood, Teachers College, Columbia University.

Dr. F. C. Caldwell, a Fellow of the Institute, and professor of electrical engineering at Ohio State University, and Dr. Morton G. Lloyd of Washington, chief of the Safety Section, U. S. Bureau of Standards and also a Fellow of the Institute, were elected to the Board of Directors.

The Hoover Committee on Elimination of Waste in Industry attributed heavy industrial losses to defective eyesight of workers. The Eye Sight Conservation Council cooperated with the Committee, and has carried on extensive research in this field.

Special Courses at Carnegie Institute

Courses for teachers of electricity and industrial education will be given during a six weeks' period between June 28 and August 9, 1929 at the Twelfth Summer Session of the Carnegie Institute of Technology in Pittsburgh, according to an announcement from Dr. Roscoe M. Ihrig, director of summer courses. The courses will be given under the supervision of the Department of Electrical Engineering; and although, as the announcement indicates the courses in electricity are outlined primarily for teachers and supervisors, the work is also designed to have a special appeal to undergraduates and those who desire higher technical training. Courses available include Principles of Electricity, Elementary Electric Wiring, and Advanced Electric Wiring. Also, the College of Industries, will give courses in Welding, and the college of Engineering will give various subjects under Chemistry, Physics, Mechanics, Surveying, and Engineering Drawing.

ENGINEERING FOUNDATION

ANNUAL REPORT

The Annual Report of Engineering Foundation for the year ending February 21, 1929, the fourteenth year of its existence, has just been issued. The following is an extract from opening paragraphs and a summary of the financial statement. The complete report can be obtained by addressing Engineering Foundation, 29 West 39th St., New York, N. Y.

"Experience is showing year after year the actual usefulness and the much greater possibilities of the joint research organization of our four senior national engineering societies with their 60,000 members. Even with small and uncertain resources, many members of these societies on special research committees are making valuable contributions of knowledge for the betterment of engineering and industrial practises. The engineer's studies must include the effects of his technical activities upon his fellow humans and their social organization. A science of humanics should be built up by research.

During the year, the Foundation continued its aid to researches concerned with arch dams, concrete arches, steel columns for bridges and buildings, blast furnace slags, electrical insulation, lubrication, engineering education and painting of wood. Much energy was devoted, besides, to preliminary inquiries and other preparations for two large new research projects: alloys of iron and wire ropes.

CONDENSED FINANCIAL STATEMENT
Calendar Year 1928

Resources		
Balance January 1, 1928		
Temporary investments, Government securities	$28,303.38	
Cash	3,491.67	$31,795.05
Receipts—Summary		
Income from endowment and temporary investments	$31,075.73	
Income from sale of publications	453.98	
Loss by maturity of U. S. 3rd Liberty bonds	3.06	31,526.65
Total resources		$63,321.70
Expenditures—Summary		
Research projects	$18,751.30	
Promotion of Research	7,640.00	
Administrative expenses	3,565.00	
Total for furtherance and support of research		$29,956.30
Balance January 1, 1929		$33,365.40

PERSONAL MENTION

Ernest V. Pannell, Consulting Electrical and Metallurgical Engineer, is now occupying offices in the Chanin Building, 122 East 42nd Street, New York, N. Y.

E. F. Whitney, manager of the Portland office of the General Electric Company since 1923 has been appointed Assistant Manager of the East Central District with headquarters at Cleveland.

Walter W. Meiers has resigned from the position of Assistant Engineer with the N. Y. Central Railroad, New York City to become Power Engineer with the B. F. Goodrich Rubber Co., Akron, Ohio.

John E. Yarmack, formerly of the Victor Talking Machine Company, is now with the firm of Foote, Pierson & Co., Inc., as Chief Engineer and Superintendent. The firm, which has been in New York City since its inception now moves into a new plant located at 75 Hudson Street, Newark, N. J.

J. B. Clapp, who prior to March 1 was associated with the Public Service Electric and Gas Company's Distribution Department, Newark, New Jersey, is now with the Copperweld Steel Company, as Sales Engineer in charge of the New York Office at 50 Church St.

William N. Reinhard, recently of the Lower St. Lawrence Power Company of Rimonski, Quebec, in the capacity of Chief Engineer, has become the United States representative of the T. D. Berry Co., Ltd., manufacturers and distributors of an instrument for live line testing of transmission line insulators.

E. Herzog has resigned from his position as Research Engineer of the General Electric Company, West Lynn, Mass., to become Electrical Testing Engineer with the State Line Generating Company at Hammond, Ind., in charge of the Electrical Testing Section of the Operating Department.

J. C. Lincoln, formerly President of the Lincoln Electric Company, Cleveland, has been elevated to the position of Chairman of its Board of Directors. Mr. J. F. Lincoln, formerly Vice-President and since 1912 an outstanding figure in the electrical industry, and among the first to envision the enormous potentialities of electric arc welding, now becomes President.

William J. Lewis, Jr., member of the Van Rensselaer H. Greene management organization, has been transferred to

Rochester as its Secretary and General Manager and a Director of the Rochester Ice & Cold Storage Utilities, Inc., which owns and operates four ice plants and three cold storage warehouses, all electrically driven in the city of Rochester and a 12,000-ton Natural Ice property at Conesus Lake.

Walter Roland Roxbury, who for three years was Specification Engineer with the New York Rapid Transit and later Coordination and Specification Engineer in the Bureau of Equipment and Operation of the Board of Transportation, has recently resigned from the later organization to accept a position as Electrical Engineer of the New Yorker Hotel Corporation to supervise the installation of the entire isolated plant, auxiliaries and associated systems.

Obituary

Seizo Misaki, who was elected to membership in the Institute in December 1899 when he was chief engineer and superintendent for the Hanshin Electric Railroad Company, Kotee, Japan, died at his home at Ashiya, near Kobe, February 23, 1929, after a brief illness of only a few days. Born at Hiogo Gen, Japan, July 1867, Mr. Misaki was educated in the common and high schools there, and after his graduation, served a year as a teacher. Subsequent education was in a private, higher school at Tokyo. In 1887 he learned English in grammar-school at San Francisco and later in the boys' high school. In 1891-92 he was a student at the Stanford University and was graduated from the Electrical Department of Purdue University in 1894. He then entered the engineers office of the Miyoshi Electric Works, Tokyo, and was also consulting engineer for the Kitano Electric & Mfg Co., Osake, Japan. From 1895 to 1899 he acted as popular consulting engineer at Tokyo designing several large plants and machinery,—in fact, almost all the newer type of machinery manufactured by the Miyoshi Electric Works was of his design. While still a resident of Japan, Mr. Misaki made short trips to the United States to study electrical progress, especially with regard to railroading. Immediately prior to his death his court standing was raised to the sixth rank, junior grade in recognition of his services to the State.

William Nelson Motter, who has been prominently identified with the Allis-Chalmers Manufacturing Company, died March 9 at Milwaukee, Wis., at the age of 55. Mr. Motter joined the Institute in 1910 as an Associate and was made a Fellow in 1912. After teaching for two years at Purdue University, from which he graduated in 1896 with honors, he began his engineering career. For the last twenty years he has engaged in the design of direct-current machinery for the Allis-Chalmers organization; that for the exposition at San Francisco in 1915 was also designed and installed by Mr. Motter, as well as that for similar projects at Niagara Falls and Philadelphia. He was a member of the Milwaukee Engineering Society, Milwaukee, Wisconsin, which has been his city of residence for some time.

Valere A. Fynn, nationally known consulting engineer and inventor, a member of the Institute since 1909 and a Fellow since 1912, died March 20 at St. Luke's Hospital, St. Louis, Mo. He was 58 years of age. Born in Russia, when his father, Irish by birth, was building the imperial railroads there, he received his technical education at the Swiss Federal Polytechnic, Zurich. His practical engineering experience was obtained with Brown Boveri & Company, Switzerland, and with Easton, Anderson & Golden in London. He subsequently established his own consulting engineering offices in London. Perhaps his greatest achievement was his contribution to the development of the single-phase motor and other inventions relating to motors, among which the Fynn-Weichsel motor is outstanding. In 1905 he published his solution of the problem of speed regulation of single-phase motors following a long series of inventions in this field, the development of a number of new motors and the improvement of types already existent; in fact, Mr. Fynn had come to be recognized as an authority on patent matters and had over 300 patents to his credit in nine different countries. His single-phase motors were manufactured by the Elektricitäts-Gesellschaft Alioth of Switzerland, France, Germany, Italy and Spain and the General Electric Company of England. In 1909 he transferred his interests to the United States, and from that year until 1921 he was consulting engineer for the Wagner Electric, which took out licenses under almost all of his numerous patents. During the twelve years of his affiliation with this Company, Mr. Fynn gave it his almost undivided attention, but since 1921 he has been engaged in an independent consulting engineering service, with offices in St. Louis, Missouri. He was a member of the Institution of Electrical Engineers, London and was an enthusiastic outdoor man, holding membership in the Alpine Club (London) the Swiss Alpine, the Academical Alpine (Zurich), the American Alpine, the Canadian Alpine, the French Alpine, Italian Alpine and the Racquet of St. Louis. His is one of the oldest families of Galway County, Ireland. His contributions to technical literature are, "A Single-Phase Commutator Motor," "Torque Conditions in Alternating-Current Motors," "The Design of Direct-Current Machinery," "Characteristics of the Asynchronous Single-Phase Shunt Induction Generator with Self-Excitation," "A Contribution to the Theory of the Single-PhaseInduction Motor," "The Classification of Alternating-Current Motors," "No-Load Conditions in Self-Excited Single-Phase Shunt Induction Motors," "Factors Affecting the Design of Self-Excited Single-Phase Shunt Induction Motors," "A New Self-Excited Synchronous Induction Motor," "Another Form of Self-Excited Synchronous Induction Motor," "A New Separally Excited Synchronous Induction Motor." Many of which were presented before the membership of the Institute at its various conventions.

A. I. E. E. Section Activities

FUTURE SECTION MEETINGS

Cleveland

Annual Dinner Meeting. Speaker: R. F. Schuchardt, President, A. I. E. E., Electric League Rooms, Hotel Statler, May 23.

Columbus

Power Supply for Railway Signals and Automatic Train Control, by C. F. King, Jr., Westinghouse Electric & Mfg. Co. Afternoon session, 2:30 p. m., Ohio Power Co. Building, Newark, Ohio. Inspection of Pennsylvania Railroad automatic train control substation in Newark. Evening session, 6:30 p. m., Chittenden Hotel, Columbus. Ladies Night. Election of officers. May 24.

Detroit-Ann Arbor

Overhead Line Research. Ann Arbor, May 21.

Lehigh Valley

Power Transmission, by A. O. Austin, Ohio Insulator Co. Inspection of Hazleton Service Depot. Altamont Hotel, Hazleton. May 10-11.

Madison

Election of Officers and showing of Baron Shiba's high speed film. May 22.

Niagara Frontier

The Cascade Tunnel, by J. B. Cox, General Electric Co. Election of officers. May 24.

Pittsburgh

Ladies Night. Meeting and Dinner Dance. May 14.

St. Louis

May 15.

June 19.

Seattle

Competitive Papers. May 21.

Sharon

Communism, by Capt. J. R. O'Brien. Banquet Meeting. June 4.

Toronto

Ladies Night. Election of Officers. May 10.

Utah

Joint meeting with University of Utah Branch. May 13.

Vancouver

Annual Dinner. June 4.

Washington

High-Capacity Mercury Arc Rectifiers, by F. A. Faron, General Electric Co. May 14.

NEW YORK SECTION

Expansion of Activities

As announced in the April issue of the Journal, the New York Section has recently had under consideration a considerable expansion of its activities, including the organization of several groups for the purpose of carrying on activities that are deemed of particular interest to such groups. The "Power Group" has already organized and it held a meeting on the evening of April 10 as reported below.

At a meeting of the Executive Committee of the Section held on April 3 the following plan "for expanding the activities of the New York Section" was adopted:

Whereas, Sec. 26 of the By-laws of the New York Section state that "in order to provide for the proper handling of the Section's routine work and the management of its affairs, the Executive Committee may adopt in connection with these By-laws such rules and regulations as may be found necessary; but no rule or regulation shall be adopted which will conflict with these By-laws or with the Constitution and By-laws of the Institute;" and

Whereas, it appears desirable to expand the activities of the New York Section in order to provide opportunities for greater participation by the membership, particularly the younger group, in its various activities, both technical and administrative; and

Whereas, this matter has been considered by special committees of the New York Section, which, after careful consideration, have made various recommendations as outlined below; therefore

Resolved: That the following regulations be hereby adopted, to take effect immediately:

Technical Groups

Organization. Technical Groups shall be organized for the purpose of conducting meetings and carrying on other activities that are deemed of particular interest to such groups, but open to the entire membership of the Section, for example

A Power Group
A Transportation Group
A Communication Group

(The Power Group has already organized and has elected temporary officers to serve until there is an election of officers whose terms will begin August 1, 1929.)

Whenever there appears to be a desire on the part of the membership to organize a new Group, the chairman of the Section shall appoint a special committee to investigate the matter and report its recommendations to the Executive Committee of the Section. If a decision is made to organize a Group, the chairman of the Section shall then appoint an Organizing Committee, which shall be responsible for making the proposed plan known to the membership of the Section, and shall arrange for and conduct an election of temporary officers to serve until the next regular election.

Officers and Executive Committee. The Officers of each Group shall include a chairman, a vice-chairman, and a secretary; and the Executive Committee, which shall be responsible for all activities of the Group, shall consist of these three officers, and such other members as they shall elect.

Election of Officers. Each year, prior to March 1, the chairman of each group shall appoint a Nominating Committee, which shall report its recommendations regarding the nomination of officers to the first meeting of the group held after March 15, at which meeting other members in addition to those named by the Nominating Committee may be added to the list of nominees by a majority vote of the meeting; and at the next meeting of the Group, officers shall be elected from this list of nominees, by majority vote of the members of the New York Section present, for the term of one year beginning on the following first day of August, and thereafter until their successors are elected.

Committees. The chairman of the Group shall appoint such committees as may be deemed desirable to carry on the meetings or other activities subject to the approval of the Group Executive Committee.

Ex-Officio Membership on various Committees of the Section The Chairman of each Group shall be a member, ex-officio, of the Finance Committee of the Section, thus providing for the necessary coordination in connection with the financing of all Group activities.

The chairman of each Group Committee shall be a member, ex-officio of the corresponding committee of the Section.

Relations with Institute Headquarters. The relations between the New York Section and the National Headquarters in New York are in general identical with the relations between the other Sections and Headquarters; but the New York Section, in accordance with arrangements made with the National Secretary, may have the advantage, if desired, of the use of the facilities of the mailing department maintained at Headquarters, including the addressograph stencils for the entire New York Section membership. (Separate mailing lists for the different Groups will not be maintained.) A proper charge against the funds available for the New York Section will be made for this service.

Reports. Reports of all Group activities shall be made by the secretary of each Group to the secretary of the New York Section, who, in turn will make reports to the National Secretary, as required by Sec. 58 of the Institute Constitution.

As a step in carrying out this plan the Executive Committee deemed it desirable to provide for the expansion of the standing committees of the Section and accordingly, a proposed amendment to the By-laws was approved by the Executive Committee and a copy of the proposed amendment was mailed to all the members of the Section accompanied by a notice that the proposed amendment would be voted upon at the next meeting of the Section on April 26.

The amendment provides for five standing committees, in addition to the Executive committee, as follows: (1) Program; (2) Entertainment; (3) Membership; (4) Finance; (5) Publicity.

CONTACTS BETWEEN ENGINEERS AND THE PUBLIC DISCUSSED BY THE TORONTO SECTION

At a meeting of the Toronto Section held on March 8, 1929, E. M. Ashworth, Gen. Mgr., Toronto Hydro-Electric System, presented a paper entitled *The Electrical Engineer and the Public*, in which he discussed the natural tendencies of engineers toward concrete and physical ideas and away from the metaphysical and abstract, with an inclination toward repression of visionary tendencies. Methods by which engineers can serve the public were mentioned.

Important contributions to the discussion of this subject were made by Chairman E. M. Wood, Vice-President, A. B. Cooper, W. P. Dobson, A. E. Davison, C. E. Sisson, H. C. Powell, and Wills MacLachlan, all of whom emphasized the importance of wider contacts between engineers and others.

President R. F. Schuchardt urged that engineers serve the public through the dissemination of the specialized information with which they are so familiar. As specific instances in which they might be of real service, he mentioned traffic, zoning, conservation of beauty spots, presentation of humanistic aspects of engineering, contacts with students and recent graduates, etc.

Efforts of the University of Toronto to develop the cultural side of the students were summarized by Professor H. W. Price. Attendance 82.

JOINT SECTION AND BRANCH MEETING IN CLEVELAND

The second annual Joint Meeting of the Cleveland Section and the Case School of Applied Science Branch was held in the Electrical Building, Case School of Applied Science, on March 19th, 1929. The dinner preceding the program was attended by eighty persons and was made especially interesting by informal introductions by Professor H. B. Dates, the first Chairman of the Cleveland Section, of seven other Past Chairmen, Mr. Henderson the present Chairman, and several guests.

The program, which was arranged for by the officers of the Case School of Applied Science Branch, was as follows:

Welcome, W. A. Thomas, Chairman, Case School of Applied Science Branch.

Address, E. W. Henderson, Chairman, Cleveland Section, A. I. E. E.

Activities of the Case Branch, W. A. Thomas, Chairman, Case School of Applied Science Branch.

Address, J. L. Beaver, Vice-President, Middle Eastern District, A. I. E. E.

The Motor Coach in Urban Transportation, L. W. Bale, Member, Case School of Applied Science Branch.

The Failure of Our Present Definition of Capacity, R. W. Schindler, Member, Case School of Applied Science Branch.

The Student Branch as a Part of the Institute Organization, H. H. Henline, Assistant National Secretary, A. I. E. E.

After the program, at which the attendance was about 125, all the laboratories were open for inspection, and all present enjoyed this opportunity to become better acquainted with the work done by the electrical engineering department as well as to engage in informal discussion.

JOINT SECTION AND BRANCH MEETING AT MILWAUKEE

The Milwaukee Section and the Student Branches at Marquette University and the School of Engineering of Milwaukee held a joint meeting at the School of Engineering on March 6, 1929, and participated in a symposium on the subject *What does the College Graduate Expect of Industry and What does the Industry Expect of Him?*

The students' side of the subject was presented by the following men who were chosen by competition in their Branches:

J. Hahn, Marquette University
Henry Haase, Marquette University
George Henkel, School of Engineering of Milwaukee

The industrial aspects were presented by the following local engineers:

H. S. Day, Wisconsin Telephone Co.
E. G. Peterson, Cutler-Hammer Mfg. Co.
W. J. McCarter, Milwaukee Elec. Ry. & Lt. Co.

President R. F. Schuchardt closed the program with a summary of the talks mentioned above.

The Section announced the establishment of two prizes for student papers presented in the Milwaukee territory by May 2, 1929; a first prize of $25.00 and suitable medal, and a second prize of $10.00 and medal. The attendance was 76.

RECENT NEW YORK SECTION MEETINGS

New Developments in Electrothermics and Electrochemistry. On the evening of Friday, March 22nd, the New York Section had as a speaker, Dr. Colin G. Fink of Columbia University. Dr. Fink gave a very interesting review of recent progress in electrochemistry and electrothermics, touching upon the developments in the electric furnace industries; in steel, the ferro-alloys; the growth of aluminum and the new beryllium. Methods of combating corrosion; the use of chromium; the electrochemistry of gases. The talk was illustrated with many slides and exhibits of articles now being manufactured as a result of the progress described. Dr. Fink closed his talk with a description of the work he is doing for the museums of New York in the restoration of ancient bronzes.

Power Group Meeting. On April 10 the first meeting of the newly organized "Power Group of the New York Section" was held. The new plan of increased New York Section activities is described in detail elsewhere. The meeting was held in Engineering Societies Building. George Sutherland, temporary chairman of the Power Group presided and opened the meeting by calling on Chairman Tapscott of the New York Section who outlined the new plan of group activities. The first scheduled speaker, L. G. Colson of the United Electric Light and Power Company gave a talk on the "Proposed Vertical Network Distribution Plan for Serving the Chrysler Building." He was followed by J. M. Comly of the Brooklyn Edison Company who described the "Design Features of Network Equipment Used in Brooklyn—Relation between Large Customer Services and Network System—Network Voltage Regulation." Both talks were illustrated. Considerable discussion then followed on both presentations. There was an unexpectedly large attendance, over 350 members and guests being present.

PAST SECTION MEETINGS

Akron

Modern Power Plant Design and Some Possibilities in High-Pressure Applications in the Future, by E. H. McFarland, Mgr., Philo Plant, Ohio Power Co. Talk by Prof. J. L. Beaver, Vice-President, Middle Eastern District, A. I. E. E., on his recent trip to England and the Continent. At a dinner preceding the program Prof. Beaver gave a short talk on the activities of the Institute. Joint meeting with Akron Section, A. S. M. E. March 8. Attendance 84.

Baltimore

Welding of Steel Bridges and Buildings, by F. P. McKibben, Consulting Engr. Illustrated. Baltimore Section, A. I. E. E. invited to meet with A. S. C. E. Section and the Engineers' Club of Baltimore. October 26. Attendance 50.

Inspection trip to Steel Plant, Sparrows Point. Joint with A. S. M. E. and the Baltimore Engineers' Club. November 9. Attendance 250.

High Tension Insulators, by D. H. Rowland, Research Engr., Locke Insulator Corp. Inspection trip to Plant of Locke Insulator Corp. was held prior to the meeting. Refreshments served. November 16. Attendance 150.

The Development of Lighter-Than-Air Ships, by W. W. Pagon. January 10. Attendance 95.

Diesel Electric Drive, by H. C. Coleman, Mgr., Marine Engg., Westinghouse Elec. & Mfg. Co. March 1. Attendance 95.

Electrical Eyes and Their Use in Communication, by John Mills, Director of Publication, Bell Telephone Laboratories. A. S. M. E., I. E. S., and Engineers' Club invited to participate. March 15. Attendance 205.

Cleveland

Joint meeting with the Case School of Applied Science Branch. See more complete report in Student Activities Dept. March 19. Attendance 125.

Cincinnati

Human Reactions to Light (with demonstrations), by Sam Freeman, Director, Lighting Bureau, The Union Gas & Electric Co. (Illustrated). D. J. Finn, Edison Lamp Works, General Electric Co., made an announcement regarding Lights Golden Jubilee Year. April 11. Attendance 46.

Connecticut

Mastery of Lightning, by F. W. Peek, Consulting Engr., General Electric Co. Bridgeport, March 5. Attendance 200.

Engineering Education, by Prof. C. F. Scott, Yale University, Slides.

Machine Tools—The Conquerors of One Thousandth of an Inch and One Second of Time, by L. D. Burlingame, Brown & Sharpe Mfg. Co. Slides. 74th meeting, joint with Waterbury Section, A. S. M. E., preceded by a dinner. March 21. Attendance 60.

Dallas

The Physical and Psychological Principles Underlying Television, by Dr. J. O. Perrine, Engr., Information Dept., American Tel. & Tel. Co. Slides and demonstrations. March 27. Attendance 343.

Denver

Social meeting arranged by the Ladies Entertainment Committee. Dinner followed by a card party. March 14. Attendance 74.

Detroit-Ann Arbor

Recent Developments in Speech Transmission, by S. P. Grace, Assistant Vice-President, Bell Telephone Laboratories, Inc. Demonstrations. Joint meeting with Detroit Engineering Society, preceded by a dinner. J. J. Shoemaker, Chairman, Membership Committee, reported upon the work of the Committee and announced the appointment of a special Graduates Follow-Up Committee of the Membership Committee. March 15. Attendance 250.

Erie

Welding, by D. H. Deyoe, General Electric Co., Schenectady, and R. C. Marthens, Westinghouse Electric & Mfg. Co. Slides. March 19. Attendance 140.

Fort Wayne

Gaseous Discharges and Hot Cathode Neon Tubes, by C. G. Found, Research Laboratory, General Electric Co. Slides and demonstrations. Motion pictures shown before and refreshments served after the meeting. March 21. Attendance 50.

Houston

The Physical and Psychological Principles Underlying Television, by Dr. J. O. Perrine, American Tel. & Tel. Co. March 29. Attendance 250.

Kansas City

Physical and Psychological Principles Underlying Television, by Dr. J. O. Perrine, American Tel. & Tel. Co. Demonstrations and slides. Brief talks by A. E. Bettis, Director, A. I. E. E., and C. A. Ulffers, General Mgr., Southwestern Bel Tel. Co. Vice-President B. D. Hull gave a brief talk and announced the Regional Meeting to be held in Dallas, May 7-9. March 25. Attendance 300.

Lehigh Valley

What's Going on in Anthracite, by R. C. Haines, Executive Secretary, Anthracite Cooperative Association, and

Making Sound Visible and Light Audible, by John B. Taylor, Consulting Engr., General Electric Co. Slides and demonstrations. Wilkes-Barre, March 22. Attendance 161.

Louisville

Narrowcasting, by J. B. Taylor, Consulting Engr., General Electric Co. Illustrated, demonstrations. Address on planning and zoning in other cities and contemplated developments in Louiville, by Harland Bartholomew, Consulting Engr., St. Louis, recently selected as Engineer for the City Planning & Zoning Commission of Louisville. Engineers & Architects Club and Louisville Section, A. S. M. E., invited to attend. March 19. Attendance 112.

Lynn

Transatlantic Telephone Circuits, by D. W. Gilman, New England Tel. & Tel. Co., Northern Area. Illustrated lecture. Motion picture, entitled "Driving the Longest Railroad Tunnel in the Western Hemisphere." March 20. Attendance 127.

The Challenge of the New Day, by David Vaughan, Professor of Social Ethics, Boston University. Light entertainment after address. March 30. Attendance 279.

Madison

Carrier Telephone Systems, by H. R. Huntley, Transmission Engr., Wisconsin Telephone Co. Slides. March 20. Attendance 75.

Milwaukee

Telephone Repeaters, by O. F. Wallman, Wisconsin Telephone Co., and

Carrier Telephone System, by H. R. Huntley, Transmission Engr., Wisconsin Telephone Co. November 7.

Electrically Welded Steel Structures, by F. P. McKibben, Consulting Engr., General Electric Co. Meeting held with Milwaukee Engineering Society, preceded by a dinner. November 21. Attendance 165.

Power Factor and Means for Its Improvement, by S. H. Mortensen, Allis-Chalmers Mfg. Co. Slides. December 5. Attendance 53.

Application of Modern Illumination to Business, by I. L. Illing, Illuminating Engr., Milwaukee Electric Railway and Light Co. Demonstrations. January 9. Attendance 70.

The Photo-Electric Cell and Its Uses in Communication, by Dr. J. O. Perrine, American Tel. & Tel. Co. Demonstrations of talking moving pictures. February 18. Attendance 225.

Symposium on subject "What Does the College Graduate Expect of Industry and What Does the Industry Expect of Him?" See more complete report elsewhere in Section Activities Dept. March 6. Attendance 76.

Minnesota

Recent Research Development, by C. E. Skinner, Asst. Director of Engineering, Westinghouse Elec. & Mfg. Co. Demonstrations. Dinner preceded the meeting, held jointly with Minneapolis Engineers Club, St. Paul Engineers Society, A. S. M. E. Sections, and University of Minnesota Branch, A. I. E. E. March 11. Attendance 175.

Nebraska

Outstanding Achievements of Research Work in the General Electric Company, by H. D. Sanborn, General Electric Co., Chicago. Motion picture "Beyond the Microscope." Reading of general letter dated March 9, 1929, on subject "Appreciation of the Engineering Profession;" reading of President R. F. Schuchardt's message in March JOURNAL. Nominating committee appointed. L. F. Wood, Secretary, chosen as Section Delegate to Summer Convention. March 28. Attendance 30.

Niagara Frontier

Experiences with the White Indians of Darien, by R. O. Marsh, Research Engr., Dupont Rayon Co. Maps and slides. Music. Dinner preceded the meeting. A. I. E. E. Ladies Night. January 18. Attendance 40.

Oklahoma

The Engineer in the Public Utility, by H. S. Thompson, Consulting Engr., Oklahoma City. Short talk by Dean Felgar, University of Oklahoma, on some of the educational problems in engineering. Dean Phillip S. Donnell, Oklahoma A. & M. College, gave a brief talk. Prof. F. G. Tappan, University of Oklahoma, made an announcement regarding Regional Meeting to be held in Dallas, May 7-9, March 12. Attendance 60.

Philadelphia

Joint meeting with Student Convention. See page 330 of April JOURNAL for complete report. March 11. Attendance 205.

Measurement of the Effects of Lightning on Transmission Lines, by E. S. Lee, General Engineering Laboratory, General Electric Co. Illustrated with slides and moving pictures. Dinner preceded the meeting. April 8. Attendance 108.

Pittsburgh

Long Distance Toll Cable Transmission, by J. A. Cadwallader, Engr. of Transmission & Outside Plant, The Bell Telephone Co. of Pa. Joint with Electrical Section, Engineers Society of Western Pa. March 12. Attendance 101.

Portland

Fifty Years Progress in Bridge Building, by Dr. Steinman of Steinman & Robinson, Consulting Engineers. Joint meeting of all engineering societies. March 8. Attendance 130.

Recent Research Developments of the Westinghouse Electric & Manufacturing Company, by C. E. Skinner, Assistant Director of Engineering. March 21. Attendance 120.

Rochester

Progress of X-Ray in Medicine, Research, and Industry, by E. C. Jerman, Director, Educational Dept., Victor X-Ray Corp. Slides. Joint meeting with Rochester Engineering Society and Rochester Section, I. R. E., preceded by a dinner. March 15. Attendance 77.

St. Louis

Electric Call System, by W. F. Callahan, Western Union Telegraph Co. Slides. Nominating Committee elected. Attendance prizes awarded to Elmer Aschemeyer, H. Norman Chapman, Jr., Geo. R. Thatcher, W. R. Waller, E. G. McLagan, and G. A. Waters. March 20. Attendance 65.

San Francisco

The Electrical Breakdown of Gases at Atmospheric Pressure, by Dr. L. E. Loeb, University of California. Local members, American Chemical Society, invited. Dinner preceded meeting. Entertainment provided by three students of University of California. March 1. Attendance 140.

Schenectady

The Transformer for Superpower Transmission and Distribution, by H. O. Stephens, General Transformer Engg. Dept., General Electric Co., Pittsfield. January 25. Attendance 150.

High Tension Underground Cable Research and Development, by G. B. Shanklin and G. M. McKay, General Electric Co.;

Line-Start Induction Motors, by C. J. Koch, General Electric Co., and

Telemetering, by C. H. Linder, C. E. Stewart, H. B. Rex, and A. S. Fitzgerald, General Electric Co. The above papers were presented at the A. I. E. E. Winter Convention. February 1. Attendance 200.

Latest Developments in Traffic Control, by J. G. Regan, Central Station Dept., General Electric Co. February 15. Attendance 200.

Modern Engineering Economics, by Dean D. S. Kimball, Dean of the College of Engineering, Cornell University. March 8. Attendance 400.

Seattle

The National Engineering Societies and Their Cooperation in National and International Matters, by C. E. Skinner, Assistant Director of Engineering, Westinghouse Electric & Mfg. Co. Annual joint meeting of local sections of the four Founder Societies. Dinner preceded the meeting, with musical program and addresses by C. E. Skinner, Lieut. Col. H. C. Fiske, R. H. G. Edmonds and George W. Evans March 19. Attendance 170.

Spokane

Recent Research Development of the Westinghouse Electric & Manufacturing Company, by C. E. Skinner, Asst. Director of Engineering of that Company. March 15. Attendance 29.

Springfield

Activities of Underwriters' Laboratories, by G. B. Muldaur, General Agent, Underwriters' Laboratories. Nominating committee appointed. March 11. Attendance 38.

Syracuse

General Principles of Power Plant Construction, by V. E. Alden, Mechanical Engr., Stone & Webster Engg. Corp. Joint with A. S. M. E. Nomination of officers for next year announced. April 8. Attendance 162.

Toronto

The Electrical Engineer and the Public, by E. M. Ashworth, General Mgr., Toronto Hydro-Electric System. See report elsewhere in Section Activities Dept. March 8. Attendance 82.

Teletype, by F. Knight, Bell Telephone Co., Montreal. March 2. Attendance 101.

Utah

Manufacture of Insulators, by G. L. Wilder, District Mgr., Locke Insulator Co. Moving picture. John Salberg reelected representative on Governing Board, Engineering Council of Utah. March 18. Attendance 55.

Washington

Lightning and Lightning Protection, by J. H. Cox, Transmission Engr., Westinghouse Electric & Mfg. Co. Dinner preceded the meeting. March 12. Attendance 130.

A. I. E. E. Student Activities

CONFERENCE ON STUDENT ACTIVITIES IN DISTRICT NO. 2

In addition to the student activities program on Thursday morning, of which an account is included in the report on the Cincinnati Regional Meeting, elsewhere in this issue, the Counselors and Student Delegates met separately for luncheon on Wednesday and met together for luncheon on Thursday. All plans for these Conferences were made by the District Committee on Student Activities, of which Professor F. C. Caldwell, Counselor of Ohio State University Branch, is Chairman, in cooperation with the Regional Meeting Committee.

Of the eighteen Branches in the Middle Eastern District, 13 were represented by both Counselors and Student Delegates and two others by students only. Each of the Student Delegates presented during the Thursday morning session a two-minute report on some activity of his Branch. The principal parts of the report of R. B. McIntosh, Chairman-elect, Case School of Applied Science Branch, for which he received the first prize of $10.00, are quoted below.

"About this time, last year, the Student Branch of the A. I. E. E. at Case School of Applied Science invited the members of the Cleveland Section to meet with them in a joint meeting.

"The arrangements for the meeting were made entirely by the Branch, and the major part of the program was presented by the students. An effort was made to make the meeting entertaining as well as instructive.

"The Case Chairman presided at the meeting and welcomed the visitors. Two students presented papers of an original nature, one of which was illustrated by a motion picture film. The entertainment highlight of the evening was a comedy skit, written and played by two students who possessed unusual dramatic ability. After the meeting the visitors inspected the laboratories with the aid of student guides.

"This joint meeting met with such instantaneous success and provoked such sincere praise from the Section that a second joint meeting was warranted. It was held on Tuesday of this week. A similar program was carried through, and I am sure it was as successful as its predecessor.

"We, at Case School, feel that these meetings are quite beneficial to both the students and members of the local Section. They afford an opportunity for the students to become acquainted with engineers who are out in industry. The students can learn from them what will be demanded after graduation. On the other hand, these meetings allow the Section to become familiar with the course of instruction at Case School, and thereby gage what they can expect from a Case School graduate.

"These two meetings have proven the experiment to be sound. They have passed from the experimental stage to become an annual institution in engineering circles in Cleveland."

Luncheon Meetings

At the luncheon of Counselors and others interested on Wednesday, Professor Caldwell outlined the principal problems of the District Committee on Student Activities, as including the finding of methods to extend the interest, enthusiasm, and acquaintance of those in the work, the passing on of good ideas, serving as advisors to the A. I. E. E. in student matters, and especially the encouragement of students in the presentation of papers. Professor J. L. Beaver, Vice-President, District No. 2, and Chairman of the Committee on Student Branches, gave a summary of Branch activities and problems, in which he emphasized the importance of active participation by the students and mentioned various methods of increasing their activity, such as talks on summer employment, abstracts of published papers, reports on thesis work, debates, prizes, and the choice of good officers.

The Thursday luncheon meeting was attended by Counselors, Student Delegates, and a number of Institute officers and others interested. There was discussion of the various reasons which prevent young men from becoming Associates immediately after the expiration of their period of Student enrolment. Professor

Caldwell, who will represent the District Committee on Student Activities at the Summer Convention, was instructed to take to the Conference of Officers and Delegates the desire of his Committee that some step be taken to bridge the gap between the expiration of Student enrolment and admission as Associates, and thus encourage a larger number to make their connections with the Institute continuous.

Professor H. E. Dyche, Counselor, University of Pittsburgh Branch, was elected Chairman and Professor Morland King, Counselor, Lafayette College Branch, was elected Vice-Chairman of the District Committee on Student Activities for the year beginning August 1, 1929.

ELECTRICAL SHOW AT MICHIGAN STATE COLLEGE

During Farmers' Week at Michigan State College, February 4-8, the Student Branch of the Institute provided an Electrical Show having for its aims the education of the rural classes in the uses of the more common electrical phenomena and the entertainment and instruction of people especially interested in electricity. In view of these purposes the experiments and exhibits covered a wide range from the fundamental principles of the motor, generator, and transformer to television apparatus and the operation of induction furnaces. The laboratories were in full operation, showing exactly the nature of the work done by the students during the school year. It has been the custom of the Branch in the past to hold the show for three days during Farmers' Week, but this year it was held open on the fourth day, at the request of the State Board of Agriculture. The attendance was estimated at from 8000 to 8500.

CONFERENCE ON STUDENT ACTIVITIES IN DISTRICT NO. 6

The Third Annual Conference on Student Activities of the North Central District was held at the University of South Dakota on March 8 and 9, 1929. Six of the eight Branches in the District were represented by both Counselors and Chairmen, and another was represented by the Chairman only. Dean O. J. Ferguson, Vice-President, District No. 6, and Professor O. E. Edison, Secretary of the District, were present.

FRIDAY EVENING SESSION

The first session was held on Friday evening, March 8, Vice-President O. J. Ferguson presiding, and the following program was presented:

Transmission of Pictures by Wire, S. B. Hughes, Transmission Engineer, Northwestern Bell Telephone Co.

Address of Welcome, L. E. Akley, Dean of Engineering, University of South Dakota.

Employment for the Student Graduate, Professor W. C. DuVall, Counselor, University of Colorado Branch; Darrell Schneider, Chairman, University of Nebraska Branch.

In the papers by Professor DuVall and Mr. Schneider and in the discussion which followed, much emphasis was placed upon the need of students for more complete and more accurate information regarding the kinds of work that will be available to them immediatley after graduation. Some of the methods by which it was thought such information could be secured are inspection trips, summer employment, advice from faculty members who spend their summers in the industries, Branch programs devoted to summer experiences and other subjects connected with work in the various companies, and letters from former students to the faculty members. Professor DuVall emphasized the benefits received by the students from the District Conferences on Students Activities.

SATURDAY MORNING SESSION

Vice-President O. J. Ferguson, presiding

Importance of the A. I. I. E. in Engineering Practise, Professor G. H. Sechrist, Counselor, University of Wyoming Branch; H. R. Arnold, Chairman, University of Colorado Branch; Henry Sattler, Chairman, South Dakota State School of Mines Branch.

The Branch as a Means of Teaching Ethics and the Highest Type of Professional Spirit, Professor F. W. Norris, Counselor, University of Nebraska Branch; Professor R. E. Nyswander, Counselor, University of Denver Branch; J. N. Petrie, Chairman, University of Denver Branch.

Methods of Stimulating Interest in the Branch, Professor D. R. Jenkins, Counselor, University of North Dakota Branch; Ervin Moudy, Chairman, University of Wyoming Branch; John K. Walsh, Chairman, University of North Dakota Branch.

Discussion of each of the above subjects was held immediately after the final presentation on that subject. Several speakers mentioned the various services of the Institute in contributing to the progress of electrical engineering and the development of its members. The many advantages offered to students through membership in the Branches were enumerated, and the importance of Branch activities in the future development of the Institute was emphasized. Some of the methods suggested for increasing interest in Branch meetings were talks by students on actual experiences, reading, or research; choice of most suitable time for meetings; appointment of more students on committees; and the serving of refreshments. The Conference received invitations to hold the next meeting at the University of Wyoming and the University of Denver. It was decided that the Executive Committee should choose the location.

Dr. B. B. Brackett, Counselor of the University of South Dakota Branch, was elected to represent the District Committee on Student Activities at the Annual Summer Convention at Swampscott.

Vice-President Ferguson urged that students in the District submit papers for the A. I. E. E. prizes.

Votes of thanks were extended to Dean L. E. Akley and University of South Dakota for the many considerations shown to the delegates, S. B. Hughes for his interesting address, and Vice-President Ferguson for his work of the past two years.

Luncheon, served to the delegates by the Home Economics Department of the University of South Dakota, was followed by an inspection trip to the new armory and gymnasium, the auditorium, and the museum.

STUDENT CONVENTION AT TROY, N. Y., MAY 10-11

A two-day Student Branch Convention will be held under the auspices of the North Eastern District of the Institute with headquarters at Rensselaer Polytechnic Institute, Troy, N. Y., on May 10 and 11.

A session devoted to Branch activities, a technical session with papers by Students, a banquet and inspection trips are the most important events of the meeting. The details of the program are given below.

Program

FRIDAY, MAY 10

9:00 a. m.	Registration.
10:00 a. m.	Welcome by Director Ricketts of Rensselaer Polytechnic Institute.
10:15 a. m.	Session on Branch Activities. In this session a number of the various branch officers and members will outline the activities of their respective branches during the past year.
11:30 a. m.	District Executive Committee Meeting.
12:30 p. m.	Luncheon Conference at Hendrick Hudson Hotel for Counselors and incoming Chairmen of Branches.
2:30 p. m.	Technical Session. *A Short Discussion of Magneto-Striction Oscillators*, J. L. Daley and A. F. Metzger, Yale University. *Radiation Characteristics of Grounded Vertical "L" and "T" Antennas*, L. B. Hochgraf, Rensselaer Institute. *The Development of a New Type of Indicator for Electrical Measuring Instruments*, T. A. Rich, Harvard University.

Lighting in Industry, M. M. Hubbard, Massachusetts Institute of Technology.

Further Oscillographic Studies of Alternator Short Circuits, H. E. Furman and T. S. Bills, Cornell University.

The Story of a Lightning Surge, E. W. Jones, University of Maine.

6:30 p. m. Convention Banquet at Russell Sage, 2nd, Dining Hall.

Speakers: Dr. W. L. Robb, Head of the Department of Electrical Engineering at Rensselaer Polytechnic Institute.

Mr. E. B. Merriam, Vice-President of District No. 1, A. I. E. E.

Dr. W. R. Whitney, Director of the Research Laboratory, General Electric Company.

During the day the laboratories of the Rensselaer Polytechnic Institute will be open to inspection by visitors.

SATURDAY, MAY 11

A. m. Inspection trip through the Schenectady Works of the General Electric Company.

P. m. Inspection of Erie Barge Canal Lock.

Inspection trip through steam power plant of New York Power & Light Corporation at Cranesville.

PAST BRANCH MEETINGS

Alabama Polytechnic Institute

How Talking Pictures Have Changed the Movies, by T. S. Winter, student;

Rochelle Salt Crystals, by W. Kiester, student;

Carrier Current System of Alabama Power Company, by W. J. Marsh, student, and

Paper Mills, by L. E. Owens, student. March 21. Attendance 27.

Modern Business, by J. K. Smith, student, and

Photoelectric Effects, by G. A. Beavers, student. March 28. Attendance 27.

The Conduit Shop at Wilson Dam, by O. T. Allen, student;

The Dynamic Loud Speakers, by A. C. Cohen, student, and

The Electric Propulsion of Ships, by W. Nabers, student. April 4. Attendance 20.

University of Arizona

Talking Motion Pictures, by R. B. Bonney, Educational Director, Mountain States Tel. & Tel. Co. Illustrated with talking motion picture films. February 25. Attendance 220.

Charles P. Steinmetz, by Bernard Shehane, student, and

Lightning Protection of Oil Tanks, by Harold Soliday, student. March 13. Attendance 19.

The Beginnings of Electrical Science, by George Walton, student;

The Thury System of Power Transmission, by C. A. Macris, student, and

Nikola Tesla and His Achievements, by W. E. Tremaine, student. March 20. Attendance 18.

Motion Picture Projectors, by Kenneth Kelton, student. Illustrated with motion pictures. March 27. Attendance 18.

Odd Uses of Vacuum Tubes, by Leo Killian, student, and

Engineering and Economics, by John McBride, student. April 3. Attendance 19.

Bucknell University

Films on electrical measuring instruments. March 13. Attendance 11.

Business Meeting. The following officers elected for 1929-30: President, E. C. Metcalf; Secretary-Treasurer, R. G. Tingle. March 15. Attendance 12.

University of California

Business session. Three-reel film "The Single Ridge." March 13. Attendance 22.

The High Sierras, by Prof. J. N. LeConte. Slides.

Acoustics, by B. J. Gillham. April 3. Attendance 20.

Carnegie Institute of Technology

The Deion Circuit Breaker, by W. J. Ruano, student. Film "The Single Ridge." Election of officers. Social meeting and refreshments after program. March 6. Attendance 31.

University of Cincinnati

Chalk Talk, by Prof. Daniel Cook, Dept. of Applied Arts. November 22. Attendance 68.

Trends in Public Utility Development, by H. C. Blackwell, President, Union Gas and Electric Co. February 13. Attendance 50.

A. C. Network System and Protection, by L. L. Bosch, Asst. Engr., Columbia Engineering and Management Corp. March 7. Attendance 70.

Clarkson College of Technology

In the Lands of Buddha, by Prof. H. B. Smith, Worcester Polytechnic Institute. Illustrated. Afternoon meeting.

The Quest of the Unknown, by Prof. H. B. Smith. Illustrated. Banquet in honor of Prof. Smith. March 9. Attendance 410.

Talk by Laurence J. Gorman, Chief Test and Electrolysis Engineer, New York Edison Co., on that company and public utility problems. March 22. Attendance 80.

Clemson College

Michael Faraday, by Cadet F. Kellers;

Highest Head Water Power Development, by Cadet L. F. Sander;

Inertaire Transformers, by Cadet W. G. Parrott, and

Current Events, by Cadet C. R. Martin. Picture "The Welding of Pipe Line." March 7. Attendance 22.

Railroad Radio-Telephone Equipment, by Cadet R. L. Sweeny;

Why We Cannot Neglect Arc-Welding Equipment, by Cadet C. S. Lewis;

What Goes on Inside the D. C. Electro-Magnet, by Cadet F. W. Lachicotte, and

Current Events, by Cadet L. E. Marshall. March 28. Attendance 19.

Colorado Agricultural College

Synchronous Reproduction of Sound and Scene, by Prof. H. G. Jordan, Counselor. Paul H. Lindon elected Secretary to take office immediately. January 29. Attendance 16.

American Telephone and Telegraph Company, by G. W. Ball, senior. February 11. Attendance 15.

Work in the Graduate Students Course at the Westinghouse Plant in East Pittsburgh, Pa., by Bice Johnson (Alumnus), Westinghouse Electric & Mfg. Co. February 25. Attendance 20.

Movietone and Vitaphone, by R. B. Bonney, Educational Director, Mountain States Tel. & Tel. Co. Three reels motion pictures. March 11. Attendance 70.

Three-reel motion picture "Development and Construction of Transformers" shown by Prof. H. G. Jordan, Counselor. March 25. Attendance 16.

University of Colorado

Carrier Telephony, by R. B. Bonney, Educational Director, Mountain States Tel. & Tel. Co. Sound Pictures on the same subject. March 6. Attendance 190.

Opportunities with the General Electric Company, by M. M. Boring, General Electric Co. Brief talks and demonstrations by other representatives of the Denver office of the company. March 27. Attendance 80.

Cooper Union

Liberal Education for the Young Engineer, by President H. N. Davis, Stevens Institute of Technology. Joint meeting with three other engineering societies and two mathematical clubs. Reports of the year's activities in each were read by the respective secretaries. Music and two-reel comedy. Refreshments served after meeting. April 6. Attendance 100.

University of Denver

R. B. Bonney, Educational Director, Mountain States Tel. & Tel. Co., presented educational sound pictures demonstrating carrier telephony. He also demonstrated a portable talking moving picture outfit and described some new developments in the Bell Telephone Laboratories. March 15. Attendance 193.

Chairman J. N. Petrie gave an account of the District Conference on Student Activities held at the University of South Dakota on March 8 and 9 and gave a paper on *Some Photoelectric and Glow Discharge Devices and Applications to Industry*. (From February issue, A. I. E. E. JOURNAL). March 22. Attendance 13.

University of Kansas

Roy F. Dent, student, gave a talk on his work at the Hawthorne Plant of the Western Electric Company last summer. Business session. March 7. Attendance 54.

Twenty-first Annual Banquet. Murel Douglas, toastmaster. Talks were given by Chancellor E. H. Lindley, George Hulteen, freshman class, and Kenneth McMurray, junior class. "Beggars of Life," by Volney Holmes, senior class. Faculty responses by Prof. F. E. Johnson and Dean G. C. Shaad. J. L. Harrington, Consulting Engr., gave a talk on the necessity of continuing study after graduation. March 20. Attendance 185.

X-Ray Tube and Its Use in Industry, by Clarence Laughlin, Victor X-Ray Corp. Slides. March 26. Attendance 18.

Lafayette College

Business meeting. Earl C. Albert elected Chairman for next year. March 16. Attendance 20.

Lehigh University

The Stroboscope and Its Application to Alternator Stability, by C. W. Guyatt, '29, and

The Telephone Problems, by O. W. Eshbach, special assistant personnel officer, A. T. & T. Co. Slides. Election of officers. March 14. Attendance 76.

Lewis Institute

Application of Electricity in Medicine, Ultra Violet and Infra Red Machines, by Mr. Bladwin, Victor X-Ray Corp. March 19. Attendance 102.

Motion picture, "The Grinding Stone." April 9. Attendance 75.

University of Louisville

Business Meeting. Election of officers. April 4. Attendance 13.

Michigan State College

Informal meeting, sponsored by Faculty. Film on manufacture and construction of electrical devices. Refreshments served. February 24. Attendance 35.

Mississippi A. & M. College

The Advancement of Engineering in 1928, by John Liston, General Electric Co. March 6. Attendance 50.

University of Missouri

Imhotep, the First Engineer, by Prof. J. E. Wrench, History Dept. Joint meeting with Engineers Club. March 18. Attendance 202.

A Method of Investigating Surface Iron Losses, by R. A. Foltz and H. E. Gove. Adoption of Constitution and By-Laws. March 25. Attendance 21.

Montana State College

F. W. Jordan, Westinghouse Electric & Mfg. Co., Butte, Montana, gave a synopsis of Westinghouse activities and the opportunities offered to college graduates. March 14. Attendance 92.

R. B. Bonney, Educational Director, Mountain States Tel. & Tel. Co., gave a demonstration of a talking-moving picture machine. April 1.

The Magneto Aircraft Compass, by T. R. Rhea, from *General Electric Review* April 1929. Presented by Eitaro Etow, student.

Strange Eyes That Never Sleep, by A. A. Stuart, from *Popular Science*. Presented by Frank Brown, student, and

Airway Guides and Markers, by O. W. Bard, from *Electrical World*, March 1929. Presented by Murray Davidson, Student. April 4. Attendance 73.

University of Nebraska

Prof. F. W. Norris, Counselor, gave a report on the Conference on Student Activities held at University of South Dakota, March 8 and 9. M. E. Scoville and E. R. Saylor, students, spoke on their experiences in summer employment. Business session. March 15. Attendance 51.

Necessity of a Broad Education for the Engineer, by C. N. Chubb, President, Iowa and Nebraska Light and Power Co. Film, "Airport Lighting." March 28. Attendance 35.

Newark College of Engineering

History of Ice Cream and How It is Made Today, by Mrs. Carolyn V. Wright, Dietitian, Castle Ice Cream Co. Reel of motion pictures. Refreshments served after the meeting. March 18. Attendance 31.

Electric Welding in Steel Fabrication, by Prof. A. A. Nims. Illustrated. Business session. April 1. Attendance 22.

University of New Hampshire

Railroad Radio Telephone Equipment, by J. J. Donnelly, student;

Electric Equipment in North Station, Boston, by W. C. Adams, student, and

Some Developments During 1928, by J. F. Arren, student. March 9. Attendance 29.

College of the City of New York

Theater Party. March 22. Attendance 20.

Inspection trip to Otis Elevator Company, Yonkers, N. Y. March 28. Attendance 42.

University of North Dakota

Talk by J. D. Taylor, Branch Mgr., Northwestern Bell Telephone Co., Fargo, N. D., and illustrated lecture by Mr. Brown of same company, Omaha, Nebraska. March 14. Attendance 33.

Topics Discussed at the District Conference on Student Activities, by Prof. D. R. Jenkins, and

His Trip to the District Conference on Student Activities, by John Walsh, Chairman. April 9. Attendance 32.

Northeastern University

The Transmission of Power at High Voltages, by Prof. C. L. Dawes, Harvard University. Illustrated with slides. March 19. Attendance 132.

University of Notre Dame

Three-reel film "The Single Ridge." February 18. Attendance 175.

Railway Signals, by P. E. Rist, student, and

The Close Relationship Which Exists between Metallurgy and Electrical Engineering, by Dr. E. G. Mahin. Slides. After the talk guests were shown the metallurgical laboratory and the operation of the various appliances was explained. Refreshments were served. March 4. Attendance 60.

Magneto-Striction and the Methods of Its Measurement, by K. R. Weigand, student;

The Application of Electrical Grounds, by J. A. Northcott, Professor of Elec. Engg., and

Biographical Sketch of George Simon Ohm, by P. F. Murray, student. Refreshments served. March 19. Attendance 50.

Selling Street Illumination, by M. S. Gilbert, Illuminating Engr., Westinghouse Electric & Mfg. Co., South Bend, and

Manual to Automatic Telephone System Conversion, by R. A. Fenimore, Indiana Bell Tel. Co. Refreshments served. April 8. Attendance 55.

Ohio Northern University

Business Meeting. Election of officers. March 5. Attendance 18.

Quantum Theory, by Prof. Harrod, Head of Chemistry Dept. Social, Financial and Program Committees appointed. April 4. Attendance 12.

Ohio State University

The Romance of Power, by C. M. Ripley, Publicity Dept., General Electric Co. Slides. Chairman W. M. Webster gave an account of the Regional Meeting held in Cincinnati. Dinner meeting. April 3. Attendance 53.

Oklahoma A. & M. College

The 100-Kw. Tube, by H. E. Bradford, Secretary,

Railway Electrification, by E. L. Weathers, Chairman, and

Rival Theories of Life, by John H. Cloud, Professor of Physics and Head of Dept. Experiments. Illustrated lectures. Refreshments served. March 13. Attendance 51.

Economy of Electric Pipe Line Pumping, by W. G. Stueue, Commercial Engr., Oklahoma Gas & Elec. Co. March 27. Attendance 33.

Pennsylvania State College

Talks on Experiences with the New York Edison Company, by Mr. Bricker and President Bair. February 27. Attendance 38.

Talk, demonstrations and several reels of motion pictures on Lamps, by C. J. Campbell, Westinghouse Lamp Co. March 7. Attendance 48.

University of Pittsburgh

What is Expected of the Engineering Student After Graduation?, by H. A. P. Langstaff, West Penn Power Co. March 1. Attendance 64.

Columbia, Panama and Ecuador, by S. Q. Hayes, General Engr., Westinghouse Electric & Mfg. Co. Motion picture—"Proved." Light refreshments. March 8. Attendance 36.

Princeton University

Some of the Problems of Television, by W. Wilson, student, and

Current Limiting Reactors, by W. F. Beasley, student. March 22. Attendance 10.

Rhode Island State College

Light. Lecture and experiments by Prof. C. L. Coggins, Head of Physics Dept. March 8. Attendance 15.

Inspection trip to Peacedale Mfg. Co., Peacedale, R. I. March 14. Attendance 15.

Copper Mining in Michigan, by Prof. Wm. Anderson, Counselor. March 22. Attendance 19.

The Pawtucket Hydrogen-Filled Synchronous Condenser, by F. E. Caulfield, student. Discussion of participation in student convention to be held in Troy. April 5. Attendance 14.

Rutgers University

High-Speed Circuit Breakers in Electric Railways, by W. Breazeale, '29, and

Ground Detection in Isolated D. C. and A. C. Circuits, by Mr. Wolf, '29. February 12. Attendance 25.

Deion Circuit Breakers, by Mr. Shervo, '29, and

Recent Improvements on Turbo-Generators, by Mr. Walton, '29. February 19. Attendance 27.

Quantitative Mechanical Analysis of Power System Transient Disturbances, by Mr. Welch, '29, and

Lightning Protection for the Oil Industry, by H. Lehman, '30. February 26. Attendance 26.

Milwaukee Locomotives, by H. Hobson, '29, and

The Conowingo Power Installation, by G. Weglener, '30. March 5. Attendance 27.

Motion pictures, entitled "Building New York's Newest Subway" and "Driving the Longest Railroad Tunnel in the Western Hemisphere." Joint meeting of all engineering students. March 12.

University of Santa Clara

Business Meeting. February 1. Attendance 13.

Motion picture, "Liquid Air." Business session. February 12. Attendance 18.

Motion picture, "The Single Ridge." Joint with Engineering Society of the University. February 22. Attendance 87.

Motion pictures, "Building New York's Newest Subway" and "Driving the Longest Railroad Tunnel in the Western Hemisphere." March 7. Attendance 74.

University of South Carolina

The Theory of Relativity, by T. F. Ball, Counselor. Discussion of A. I. E. E. regional and national prizes. Importance of papers from the Branch emphasized. March 6. Attendance 18.

Business Meeting. Following officers elected for next year: Chairman, G. H. Preacher; Vice-Chairman, F. H. Lucas, Jr., and Secretary-Treasurer, B. F. Karick. April 10. Attendance 14.

South Dakota State School of Mines

Chairman Henry Sattler reported upon District Conference on Student Activities held at University of South Dakota. Prof. J. O. Kammerman, Counselor, gave a talk on Student Enrolment. Prof. E. E. Clark spoke on his summer school experience at Pittsburgh, Pa. Motion pictures, "The Okonite Process of Wire Making" and "The Land of Cotton." Refreshments served. March 13. Attendance 46.

Talking Pictures, by M. E. Murphy, (alumnus), Electrical Research Products, Inc. March 26. Attendance 28.

University of South Dakota

Vacuum Tubes, by Howard Crosby, student. Business session. March 11. Attendance 10.

Discussion of plans for joint meeting in Omaha in April. March 18. Attendance 15.

University of Southern California

Oil and Vacuum Switches, by Mr. Blaksley, Bureau of Power and Light, City of Los Angeles. February 14. Attendance 23.

Business Meeting. February 21. Attendance 23.

Effect of Power Factor Variations on Primary and Secondary Voltages, and Output of Five K. W. Street Lighting Transformer, by D. R. Stanfield, student. February 28. Attendance 24.

Joint meeting with California Institute of Technology Branch and Los Angeles Section. More complete report may be found on page 331 of April JOURNAL. March 5. Attendance 240.

Business Meeting. March 7. Attendance 21.

Business Meeting. March 14. Attendance 21.

Syracuse University

Calculation of Forces on Automatic Circuit Breakers, by Mr. Allen, student, and

Electrification of a Steel Mill, by Chairman F. Casavant. W. R. McCann, Chairman, Syracuse Section, was a guest of the Branch and participated in a discussion concerning the relationship between the local Section and the Student Branch. Luncheon. February 14. Attendance 22.

Demand Limitator, by E. T. Moore, Consulting Engr. March 7. Attendance 21.

Armature Voltage Rise in a Given Time, by Mr. Bryant, student, and

Design of Plunger Type Relay and Design of a Flywheel, by Mr. Ott, student. March 14. Attendance 21.

Power Factor Correction, by Mr. Belayeff, student, and

Inductance Calculation, by Mr. Rosti, student. March 21. Attendance 21.

University of Texas

Underground Distribution Systems, by Mr. Evans, San Antonio Public Service Co. Business session. March 14. Attendance 16.

University of Vermont

Branch meeting postponed and about twenty members attended the meeting of the Vermont Society of Engineers. Papers of particular interest to Branch members were: *Electrical Science,* by C. D. Spencer; *Power Development,* by F. M. Eastman, and *The Development of Water Power as a Natural Resource,* by M. G. Clark. March 13. Attendance 20.

Demonstration of Induction Motor Principles, by K. H. MacGibbon, '29, and

Types of Induction Motors, by J. W. Wendt and A. Johnson, '29. Discussion of plans for sending a delegation to the Student Convention at Troy. March 27. Attendance 16.

Virginia Military Institute

Summer Work in a Motor Generator Plant, by M. R. Berry, student;

Holland Tubes, by A. F. Black, student;

Electrification of Rolling Mills, by W. B. Miller, student;

Airplane Testing, by B. T. Smith, student, and

Use of Radio Telephony in Railroading, by W. B. Andrews, student. March 4. Attendance 40.

Carrier Current on Power Lines, by J. C. Smith, student;

Benefits of the A. I. E. E., by H. B. Blackwood, student;

Experiences with the Gas Wells of Texas, by J. T. Brodnax, student;

New Type of Generator Ventilating Fan, by C. A. Goodwin, student, and

Philadelphia Arena and Its Electrical Equipment, by A. S. Britt, student. March 28. Attendance 39.

Virginia Polytechnic Institute

Advice to College Men, by Prof. L. J. Bray. March 7. Attendance 32.

Motion picture, "Construction and Operation of Electrical Measuring Instruments." March 25. Attendance 100.

Washington State College

Engineers' Show Committee appointed. Discussion of plans for exhibits. February 28. Attendance 13.

Discussion of plans for Engineers' Show. March 6. Attendance 19.

Mining and Electricity, by Guy E. Ingersoll, Asst. Prof. of Mining and Metallurgy. Discussion of plans for Engineers' Show and plans to get more members to attend meetings. March 13. Attendance 15.

Prof. R. D. Sloan, Counselor, spoke on the A. I. E. E. organization—purposes and publications—and urged juniors to enroll in the Institute. Harold Low, graduate student, gave a talk on the Cathode Ray Oscillograph. Business session. Refreshments. March 27. Attendance 56.

University of Washington

The Seattle Distribution System of the Puget Sound Power and Light Company, by Ray Rader, Puget Sound Power and Light Co. and Secretary of the Seattle Section. Business session. April 5. Attendance 20.

West Virginia University

Electric Heat for Homes, by Earl Milan, student; *Purified Textile Insulation*, by G. H. Hollis, student; *Projection of Sound and Scene*, by Ivan Vannoy, student; *Rate Making*, by M. C. Clark, student; *Early Development of the Electric Railway*, by T. R. Cooper, student, and *Aeroplane Show at Pittsburgh*, by C. L. Walsh, student. March 11. Attendance 22.

Treated Fabric for Insulation, by C. A. Bowers, student; *Photoelectric Cells*, by C. B. Seibert, student; *Steel Used in Switchboard Design*, by J. R. Nothingham, student; *Defects of Insulation*, by O. R. Allen, student; and *Hydrogen for Cooling Electric Machines*, by S. N. Giddings, student. March 18. Attendance 21.

Telemetering, by J. Kayuha, student; *How Hard is Rock*, by W. H. Ross, student; *The Deion Circuit Breaker*, by L. F. Oneacre, student; *Structural Steel for Generators*, by R. H. Pell, student; *Electric Aid for Navigation*, by W. C. Warman, student; and *Designing Arc Welded Machine Bases*, by G. S. Watson, student. March 25. Attendance 22.

The Use of Chromium in Alloys, by V. O. Whitman, student; *Precision in Frequency Measurements*, by L. F. Oneacre, student; and *Power Interruptions by Birds*, by E. M. Hansford, student. April 8. Attendance 15.

University of Wisconsin

Chairman Odbert outlined the meetings for the second semester February 19. Attendance 21.

Banquet. Several seniors read reports on Eastern and Western inspection trips. Discussion of the trips by students and faculty. February 28. Attendance 50.

General discussion by faculty and students on the Electrical Engineering Course at the University of Wisconsin, lead by Prof. Edward Bennett, Department Head. March 27. Attendance 18.

Engineering Societies Library

The Library is a cooperative activity of the American Institute of Electrical Engineers, the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers and the American Society of Mechanical Engineers. It is administered for these Founder Societies by the United Engineering Society, as a public reference library of engineering and the allied sciences. It contains 150,000 volumes and pamphlets and receives currently most of the important periodicals in its field. It is housed in the Engineering Societies Building, 29 West Thirty-ninth St., New York.

In order to place the resources of the Library at the disposal of those unable to visit it in person, the Library is prepared to furnish lists of references to engineering subjects, copies or translations of articles, and similar assistance. Charges sufficient to cover the cost of this work are made.

The Library maintains a collection of modern technical books which may be rented by members residing in North America. A rental of five cents a day, plus transportation, is charged.

The Director of the Library will gladly give information concerning charges for the various kinds of service to those interested. In asking for information, letters should be made as definite as possible, so that the investigator may understand clearly what is desired.

The library is open from 9 a. m. to 10 p. m. on all week days except holidays throughout the year except during July and August when the hours are 9 a. m. to 5 p. m.

BOOK NOTICES, MARCH 1-31, 1929

Unless otherwise specified, books in this list have been presented by the publishers. The Society does not assume responsibility for any statement made; these are taken from the preface or the text of the book.

All books listed may be consulted in the Engineering Societies Library.

Die Anisotropen Flussigkeiten.

By C. W. Oseen. Berlin, Gebrüder Borntraeger, 1929. (Fortschritte der Chemie, Physik und Physikalischen Chemie, ser. B., bd. 20, heft 2). 87 pp., 10 x 6 in., paper. 6.80 r. m.

In this concise treatment of anisotropic, or crystalline, liquids, the author does not attempt to review again our knowledge of the entire field. His interest is restricted to those facts about these substances for which a theoretical explanation has been proposed. The various phases which these liquids assume are discussed and the theories of different investigators given.

Begrenzung der Leistungssteigerung der Schnellaufenden Verbrennungsmachine durch den Steuervorgang.

By Manfred Christian. (Forschungsarbeiten, heft 315). Berlin, V. D. I. Verlag, 1929. 19 pp., diagrs., tables, 12 x 9 in., paper. 3,75 r. m.

An investigation of the attainable limit of speed for high-speed internal combustion engines, such as those used for automobiles and airplanes, and especially of the extent to which this limit is fixed by the capabilities of the valve gear. The author investigates the various valve-gears which have been applied to four-cycle engines and determines the highest speeds possible for various sizes. Sleeve valves and rotary valves, he concludes, offer no hope for speeds higher than those obtainable with ordinary valves.

Causeries sur les Filons Metalliques.

By Paul Audibert. Paris, Dunod, 1929. 240 pp., 10 x 7 in., paper. 33 fr.

Every young engineer finds himself faced by numerous practical problems, the solution of which is not given in the theoretical treatises which he has studied. The author of this book, a young mine manager, has had the thought of writing the results of his experience with various difficulties, for the benefit of other young mining engineers.

This book is a supplement to the ordinary texts on mining. He discusses from a practical point of view, the characteristics of veins of ore, methods of draining and working, machinery, crushing, flotation, etc. The management of labor, mine organization, welfare work and similar topics are touched upon. The young engineer upon his own, especially abroad, should find the book suggestive and helpful.

Les Compteurs D'Electricite.

By R.-M. Fichter. 2d edition. Paris, Dunod, 1929. 372 pp., illus., diagrs., 10 x 7 in., paper. 73,90 fr.

A revised and rewritten edition of a work first published in 1919. The treatment is descriptive. Chapters are devoted to the various types of meters; to questions of installation, calibration, and testing; to methods of charging for current, to the organization of meter service, and to frauds.

Conduction of Electricity Through Gases, v. 1. 3rd edition.

By Sir J. J. Thomson & G. P. Thomson. Cambridge, Eng., University press, 1928. N. Y., Macmillan Co., 491 pp., illus., diagrs., tables, 9 x 6 in., cloth. $8.50

The first edition of this celebrated work appeared in 1904; in 1906 a second edition appeared; and part of a third edition was in type when the War broke out and interrupted work upon it. It is only now that the author has been able, with the assistance of his son, to complete the task of dealing with the researches on this subject that have been made since the second edition.

The book has grown to two volumes, of which the first, dealing with the general properties of ions and ionization by heat and light, is now published. Most of the original paragraphs have been retained with little alteration except the replacement of the values of fundamental consultants by more accurate modern ones. The new matter is inserted at appropriate places. This book will be welcomed by workers in this field.

Dampfturbinen.

By Leonhard Roth. Berlin, R. Oldenbourg, 1929. 103 pp., diagrs., tables, 10 x 7 in., paper. 6,-r. m.

Dr. Roth gives a concise presentation of the principles of the design and construction of steam turbines, from which advanced mathematics is absent. Starting with a description of the principles of the turbine, he develops the design of the various parts, then the combination of these into a complete machine. Modern tendencies in design and modern constructions are discussed.

Dictionary of American Biography. Under the Auspices of the American Council of Learned Societies.

Edited by Allen Johnson. N. Y., Charles Scribner's Sons, 1928. 20 v., 7 x 10 in., cloth. $250.00 per set.

Early in the present century there developed among the learned societies of America a serious discussion of ways and means of bringing into being a dictionary of American biography which would be, for students of America, what the Dictionary of National Biography is to his colleague in Great Britain. An organization was effected, Mr. Adolph S. Ochs provided a half-million dollars for editorial work and actual preparation of copy was begun in 1925.

The managers of the work plan to include biographies of all former inhabitants of America who have made "some outstanding contribution to the tradition of America." Unusual effort has been made to make the list of names complete and to include in it certain classes who are too often neglected in works of this character.

The first volume, a handsomely printed book of 660 pages, begins with Cleveland Abbe, astronomer and meteorologist, and ends with Maurice Barrymore, actor. The first engineer to appear is Brig.-Gen. Henry L. Abbot, well known for his important early work on hydraulics and the regimen of the Mississippi River; the last is Joseph Barrell, the geologist and teacher at Lehigh and Yale.

Between these extremes the lives are recorded of forty-four other engineers and manufacturers. Among them are such men as John F. Appleby, who invented the knotter used on most grain reapers; the metallurgists, Albert Arents and Philip Argall; Isaac Babbitt, of babbitt-metal fame; the Loammi Baldwins, father and son; Mattheas W. Baldwin; Albert Ball; and Zenus Barnum, prominent in the organization of early telegraph lines, but best known as the proprietor of the famous Barnum's Hotel in Baltimore.

Others of note are Horace Abbott, who rolled the armor-plate for the *Monitor*; Alexander Agassiz; James P. Allaire, theengine builder; Horatio Allen and John F. Allen; John R. Anderson, whose Tredegar Iron Works was the backbone of the munitions supply of the Confederacy; Oakes Ames and Oliver Ames; and David Alter, the pioneer physicist.

Each biography is written by a competent authority, and the sources for the statements are given. The standard is high and as it undoubtedly will be maintained through the remaining volumes, the dictionary will be in the first rank if indispensable works of reference.

It is planned to be completed in twenty volumes, containing 16,000 biographies.

Diesellokomotiven.

By G. Lomonossoff. Berlin, V. D. I.-Verlag, 1929. 304 pp., illus., diagrs., plates, tables, 12 x 9 in., cloth. 32.-r. m.

Professor Lomonossoff gives a very able study of the present position of the Diesel locomotive in this volume. The evolution of the machine, its theory and construction are discussed in the light of the researches of the author and his colleagues, and current practice is subjected to keen critical investigation. The various types of transmission are discussed at length.

Economics of Water Power Development.

By Walter H. Voskuil. Chic. & N. Y., A. W. Shaw Co., 1928. 225 pp., diagrs., maps, tables, 8 x 5 in., cloth. $3.00.

The author has attempted to analyze the factors that govern the economic exploitation of waterpower resources. He first lays down the principles of waterpower economy, calling attention to the elements of cost. The water powers of various sections of the United States are then discussed, after which the public control of water powers and the various projects for public ownership are taken up. Much statistical material is summarized and a good bibliography is given.

Electrical Engineering Economics.

By D. J. Bolton. Lond., Chapman & Hall, 1928. 305 pp., diagrs., tables, 9 x 6 in., cloth. 21s.

Most books on economics for engineers, says this author, dwell almost exclusively on the economics of production and neglect the economics of consumption, the processes in which the greatest waste occurs.

The present book, devoted to the latter portion of the problem, aims to give electrical engineers and students a plain account of such elementary economics as most nearly concerns them, with its application to certain engineering problems. The first section presents general principles of economics. In the second, the choice of plant, the general problem of economic choice is treated. The final section deals with some of the economic problems connected with electricity supply, tariffs, load factor, power factor, etc.

Elektrotechnik, bd. 3; Die Wechselstromtechnik.

By J. Herrmann. 5th edition. Ber. u. Lpz., Walter de Gruyter & Co., 1929. 140 pp., plates, diagrs., 6 x 4 in., cloth. 1,50 r. m.

This volume of Professor Herrmann's little textbook on electrical engineering is devoted to a-c. machinery. Generators, transformers and motors are described clearly and very concisely, the principal theoretical points being explained and attention given also to practical questions of construction and operation.

Handbook of Chemistry and Physics. Comp. by Charles D. Hodgman and Norbert T. Lange. 13th edition. Cleveland O., Chemical Rubber Co., 1928. 1214 pp., tables, 7 x 5 in., fabrikoid. $5.00.

The thirteenth editon contains over a hundred more pages than the preceding one, including a section on ceramics. Many changes have been made in the tables, to make them more convenient, and corrections have been made where required.

The book is a very valuable tool for the chemist and physicist, providing in convenient form a great mass of the data that are frequently wanted in the laboratory and chemical works.

Handbook of Hydraulics.

By Horace Williams King. 2d edition. N. Y., McGraw-Hill Book Co., 1929. 523 pp, diagrs., tables, 7 x 4 in., fabrikoid. $4.00.

This book is intended primarily to assist in the solution of hydraulic problems, and presupposes a knowledge of the principles of hydraulics. The author discusses the formulas used and presents a great amount of tabulated data that will simplify calculation.

The new edition extends the application of the Manning formula to flow in pipes. A new chapter on critical depth and hydraulic jump has been added, as well as additional data on natural streams and the measurement of flowing water. The entire text has been rewritten.

Heizung und Luftung.

By Johannes Körting. Berlin, Walter de Gruyter & Co., 1929. 2 v., illus., tables, 6 x 4 in., cloth. 1,50 r. m. each.

A brief review of the design and construction of heating and ventilating installations in dwellings. The subject is presented in simple language, in a manner suited to the needs of builders and owners.

Illustrated Technical Dictionaries in . . . English, German, Russian, French, Italian, Spanish; v. 11, Electrical Engineering and Electrochemistry. Edited by Alfred Schlomann. Berlin, Technische Wörterbücher-Verlag, 1928. Distributors, V. D. I.-Verlag. 1304 pp., illus., 10 x 7 in., cloth. 80,-mk.

Every translator of electrical literature owes a vote of thanks to the editor of this work, and to the Society of German Engineers, which provided the funds for it. In its present form it is practically a new work, as it has been revised and reset, and greatly enlarged over the previous edition.

Approximately 20,000 expressions common in electrical literature are given, with their meanings in the six principal European languages. In preparing the work, the editor has had the assistance of expert engineers in each country. Wherever possible, the meaning of an expression is clarified by a sketch, formula or symbol.

The dictionary is indispensable to every translator or reader of foreign literature. It is by far the best available aid.

Der Indizierte Wirkungsgrad der Kompressorlosen Dieselmaschine.

By Fritz Schmidt. (Forschungsarbeiten, heft 314), Berlin, V. D. I.-Verlag, 1929. 22 pp., diagrs., tables, 12 x 9 in., paper. 4,50 r. m.

The investigation here reported was undertaken to make it possible to determine the indicated efficiency of Diesel engines more exactly and simply than has been the case in the past. The author subjects the customary methods to a critical study, and finally develops a method by which the indicated efficiency may be simply determined with the aid of certain tables and diagrams which he supplies.

Kompressorlose Dieselmotoren und Semidieselmotoren.

By M. Seiliger. Berlin, Julius Springer, 1929. 296 pp., illus., diagrs., 10 x 7 in., bound. 37.50 r. m.

This treatise discusses these types of engines theoretically and practically. The author presents a new theory of the in-

ternal combustion engine, in which the working process is regarded as a function of the process of combustion, time, and cooling. The laws of the combustion process are investigated and applied to semi-diesel and compressorless diesel engines. The principal commercial types of engines are examined and practical conclusions drawn.

Life of George Chaffey; A Story of Irrigation beginnings in California & Australia. By J. A. Alexander. Melbourne, Macmillan & Co., 1928. 382 pp., illus., ports., maps, 9 x 6 in., cloth. $10.50. (Gift of Macmillan Company, N. Y.)

George Chaffey arrived in California when irrigation development was in its primitive stages, and rapidly became an important pioneer in its advancement. He founded the Ontario colony, still a model of success, and devised the system of mutual water companies which has played a valuable part in promoting irrigation enterprises. Invited to Australia by the Victoria government, he founded the first larger-scale developments in that continent. Returning to the United States, he built the Imperial Valley works and the Whittier development.

His life is told in interesting fashion in this biography. Particular attention is given to the Australian period of his career, and the reasons for the financial failure of developments there is told in detail.

Die Maschinenelemente, v. 2.

By Felix Rötscher. Berlin, Julius Springer, 1929. 1354 pp., illus., diagrs., tables, 11 x 8 in., bound. 48.-r. m.

The final volume of an important treatise on machine design, publication of which began in 1927.

The book has been given great praise in Germany, both for its comprehensiveness and for its method. Its especial virtue is the attention paid to questions of manufacture and working conditions. While the mathematical and kinematical factors are fully considered, the author also gives full attention to such matters as the most economical methods of forming the elements of a machine, the selection of the best material, the conditions under which the machine will be used, and other factors that affect the efficiency of the finished product. The result is an unusually practical reference book for designers and manufacturers.

Maste und Turme in Stahl.

By P. Sturzenegger. Berlin, Wilhelm Ernst & Sohn, 1929. 219 pp., illus., diagrs., 10 x 7 in., paper. 23.-r. m.

This book, one of a library on steel construction planned by its publishers, is devoted to the construction of masts and towers for electric transmission and distribution systems. The author treats of the development and principles of line construction, transmission lines, trolley lines, anchorages and foundations, protection from corrosion, mast transportation and erection. Practical directions for design are given, and many types are illustrated and described.

Nomenclature of Petrology.

By Arthur Holmes. Lond., Thomas Murby & Co., 1928. 284 pp., 7 x 5 in., cloth. 7/6.

A reliable dictionary of rock names, including the majority of those found in geological literature. The definitions are accurate, the introducer of each term is given, and there are numerous references to the literature. Glossaries of French and German terms and of Greek and Latin words and prefixes, are given in appendices.

The new edition is a reissue of the first, with corrections, at a greatly reduced price.

Operational Circuit Analysis.

By Vannevar Bush. N. Y., John Wiley & Sons, 1929. 392 pp., 8 x 5 in., cloth. $4.00.

The purpose of this text is the presentation of the Heaviside operational calculus and allied matters in form for engineering use. It aims to bring together the substance of the developments and extensions of the methods introduced by Heaviside in his classic work, and to show how they may be applied to all sorts of circuit problems, not only in electricity, but also in acoustics, mechanics, hydraulics, and so on. The book is written primarily for engineers, rather than for mathematicians, and is based on experience in teaching the subject at the Massachusetts Institute of Technology.

Physics of the Air.

By W. J. Humphreys. 2d edition. N. Y., McGraw-Hill Book Co., 1929. 654 pp., illus., diagrs., tables, 9 x 5 in., cloth. $6.00.

In this work Dr. Humphreys discusses the whole range of physical phenomena of the earth's atmosphere and gives scientific or rational explanations of them. The book thus brings together in orderly arrangement much material that has been widely scattered and difficult to find.

The new edition contains an additional part, on meteorological acoustics, as well as many new paragraphs and topics.

Profession of Engineering; Essays. Edited by Dugald C. Jackson & W. Paul Jones. N. Y., John Wiley & Sons, 1929. 124 pp., 8 x 5 in., fabrikoid. $1.50.

This collection of essays by noted engineers is designed primarily for the young man choosing a vocation. Starting with discussions of the education of the engineer and of the factors that make for success in engineering various authors describe the main branches of the profession. The final essay by President Hoover, is on the engineers contribution to modern life.

The authors suggest the book as a text for freshman orientation courses and courses in engineering English, and as a guide to parents and others interested in the profession and the qualifications necessary for entering.

Radio. Edited by Irwin Stewart. Supplement to vol. 142 of the Annals. Phila., American Academy of Political and Social Science, 1929. 107 pp., 10 x 7 in., paper. Price not given.

The aim of this pamphlet is to give a picture of the entire field of radio in non-technical language. The articles, by many prominent specialists, deal with the development of radio, its present status, Federal legislation and its administration, its uses, and the part that it plays in international affairs.

Radio Receiving Tubes.

By James A. Moyer and John F. Wostrel. N. Y., McGraw-Hill Book Co., 1929. 297 pp., illus., diagrs., tables, 8 x 5 in., cloth. $2.50.

Explains the principles underlying their action, tells how they are constructed and describes their uses, both in radio communication and for other industrial purposes. One chapter is devoted to specification for tubes for various purposes. The treatment is as nontechnical as is consistent with accuracy.

Le Regulateur Automatique Pour Machines Electriques.

By Ernest Juillard. Lausanne, Switzerland, Payot & Cie, 1928. 176 pp., illus., diagrs., 10 x 6 in., paper. 6 fr.

The author has undertaken to interpret, by mathematical analysis, the transitory phenomena that occur at the moment when an automatic regulator comes into action. After having established a general method applicable to any type of regulator, the author makes use of it for the more special study of the automatic regulation of the voltage of generators. The mathematical results show the important role played by the various characteristics of the generator and regulator. The calculations are confirmed by a series of tests.

Speech & Hearing.

By Harvey Fletcher. N. Y., D. Van Nostrand Co., 1929. 331 pp., illus., diagrs., tables, 9 x 6 in., cloth. 5.50.

This work on the physics of speech and hearing makes available the results obtained by the author and his associates during thirteen years of work at the Bell Telephone Laboratories. It treats of the mechanism and character of speech, of the physical properties of musical sounds and noise, of the mechanism of hearing and its capacities and of the perception of speech and music.

Stratigraphical Palaeontology.

By E. Neaverson. Lond. & N. Y., Macmillan & Co., 1928. 525 pp., illus., 9 x 6 in., cloth. 6.50.

While textbooks of stratigraphy always contain some broad generalizations on the faunal aspect of stratal conceptions, says this author, the student is often left with inadequate conceptions of the application of paleontological methods to stratigraphy. The present book is designed to help him to use fossils to the best advantage in his geological work.

Part one discusses general considerations, such as mode of occurrence, habitat, geographical distribution, and migration. Part two is an account of the faunas of geological systems as they occur in Great Britain. The book contains accurate illustrations of some five hundred different kinds of fossils, which should be of service to mining engineers and geologists.

Die Theorie der Gewichtsstaumanern.

By K. Kammüller. Berlin, Julius Springer, 1929. 60 pp., diagrs., tables, 9 x 6 in., paper. 5.40 r. m.

This little book discusses some important problems of dam design, its purpose being to present some valuable results of theoretical investigation into the strength of gravity dams in a form that will be easily applicable in practice. The topics treated include uplift, the pressure conditions, the stresses, and the position of the expansion joints.

Theory of Heat Engines.

By William Inchley. 3d edition. N. Y., Longmans, Green & Co., 1929. 504 pp., diagrs., 9 x 6 in., cloth. $5.00.

In order to have space for a complete exposition of both the thermo-dynamical and mechanical principles of the subject, all purely descriptive matter has been omitted from this book. It aims to give concisely a thorough course in the theory of heat

engines, adapted to the courses given university students of engineering. The new edition has been edited by Dr. Arthur Morley, who has made various amendments and corrections.

VIBRATION PROBLEMS IN ENGINEERING.

By S. Timoshenko. N. Y., D. Van Nostrand Co., 1928. 351 pp., 9 x 6 in., cloth. $4.50.

An exposition of the fundamentals of the theory of vibrations with special reference to the application of the theory to such practical problems as the balancing of machines, the vibrations in turbines and in railroad track and bridges, and the whirling of rotating shafts. The topics discussed include harmonic and non-harmonic vibrations in systems with one degree of freedom, in systems with several degrees of freedom, and in elastic bodies. A chapter on measuring instruments is included. Applications to various engineering problems of importance are developed.

WARME-UND KALTESCHUTZ IN WISSENSCHAFT UND PRAXIS. 186 pp., illus., tables, 9 x 6 in., bound. 16.-r. m.

DIE GRUNDLAGEN FUR DEN VERGLEICH VON WARMESCHUTZ-ANGEBOTEN. 63 pp., diagrs., tables, 8 x 6 in., bound. 7,60 r. m.

DIE TECHNISCH-RECHTLICHE BEDEUTUNG VON GARANTIEN AUF DEM GEBIETE DES WARME-UND KALTESCHUTZES. 62 pp., 8 x 6 in., bound. 6,50 r. m.

Köln-Rhein, Deutsche Prioform Werke Bohlander & Co., 1928. For sale by Julius Springer, Berlin.

These three volumes issued by the Deutsche Prioform Werke contain technical data and advice to purchasers of heat-insulating materials based on the experience of that firm of manufacturers.

Wärme-und Kälteschutz is a general work on the principles and practice of heat insulation. The conduction of heat, the calculation of insulation, the testing of insulating materials, various methods of insulating, and the raw materials used are discussed. The book summarizes the data needed in designing and selecting materials and methods.

Grundlagen für Vergleich der Wärmeschutzangeboten aims to assist the buyer in comparing tenders from various firms. Technisch-Rechtliche Bedeutung von Garantien is a discussion of the technical and legal points of manufacturer's guaranties.

WEGE UND ZIELE DES DEUTSCHEN MUSEUMS. By W. Von Dyck.

HEINRICH HERTZ. By J. Zenneck.

(Deutsches Museum. Abhandlungen und Berichte, heft 1 & 2.) Berlin, V. D. I. Verlag, 1929. heft 1, 30 pp.; heft 2, 36 pp., illus., ports., 8 x 6 in., paper. 1,-r. m. each.

These pamphlets are the first two numbers of a bi-monthly publication which will be issued under the auspices of the Deutsches Museum and the Society of German Engineers, and which will be devoted to brief popular accounts of important technical developments, biographies of scientists and engineers, museum collections, etc.

The first number contains an account of the beginnings of the Deutsches Museum, of its organization, developments and purposes. The second is devoted to an account of the life and work of Heinrich Hertz, in which Dr. Zenneck gives an able brief review of his discoveries and their influence on electrical engineering.

WIDERSTANDSMESSUNGEN AN UMSTROMTEN ZYLINDERN VON KREIS-UND BRUCKENPFEILERQUERSCHNITT.

By F. Eisner. Berlin, Julius Springer, 1929. (Mitteilungen der Preussischen Versuchsanstalt für Wasserbau und Schiffbau, Berlin. Heft 4) 98 pp., illus., diagrs., tables, 11 x 8 in., paper. 10.-r. m.

This is an experimental contribution to the question of the resistance to motion of solids in liquids. It is the first portion of a comprehensive, systematic investigation of the resistance of structures resembling bridge piers in open channels, and of the effect of various shapes upon their resistance. The present report is in three parts. Part one shows the distribution of pressure and the amount of resistance in the case of cylindrical bodies. Part two is a review of the present teachings of hydrodynamics concerning resistance and the formulas proposed for computing it. Part three gives the results of experiments with bodies similar in cross-section to bridge piers.

These investigations were made at the Prussian Experimental Institute for Hydraulic Engineering and Naval Architecture, and have been in progress since 1913.

ZUGFESTIGKEIT UND HARTE BEI METALLEN.

By Otto Schwarz. (Forschungsarbeiten, heft 313). V. D. I. Verlag, 1929. 34 pp., diagrs., tables, 11 x 8 in., paper. 6 r. m.

With the growing use of non-ferrous metals and the very general use of the ball test upon semi-finished and finished products, a clear understanding of the theoretical and practical connections between tensile strength and hardness becomes very important. These relations are very carefully studied in this report. The author first investigates the question theoretically and derives laws showing the relationship. He then describes his laboratory investigations in detail, gives the experimental results obtained with brass, nickel, aluminum, duraluminium and skleron, and supplies tables, based on these results, giving the factors for converting hardness into tensile strength. The relation of strength to hardness for copper and steel at higher temperatures and for cast metals is also shown.

Engineering Societies Employment Service

Under joint management of the national societies of Civil, Mining, Mechanical and Electrical Engineers cooperating with the Western Society of Engineers. The service is available only to their membership, and is maintained as a cooperative bureau by contributions from the societies and their individual members who are directly benefited.

Offices:—31 West 39th St., New York, N. Y.,—W. V. Brown, Manager.

1216 Engineering Bldg., 205 W. Wacker Drive, Chicago, Ill., A. K. Krauser, Manager.

57 Post St., San Francisco, Calif., N. D. Cook, Manager.

MEN AVAILABLE.—Brief announcements will be published without charge but will not be repeated except upon requests received after an interval of one month. Names and records will remain in the active files of the bureau for a period of three months and are renewable upon request. Notices for this Department should be addressed to ***EMPLOYMENT SERVICE, 31 WEST 39th Street, New York City,*** *and should be received prior to the 15th day of the month.*

OPPORTUNITIES.—A Bulletin of engineering positions available is published weekly and is available to members of the Societies concerned at a subscription of $3 per quarter, or $10 per annum, payable in advance. Positions not filled promptly as a result of publication in the Bulletin may be announced herein, as formerly.

VOLUNTARY CONTRIBUTIONS.—Members obtaining positions through the medium of this service are invited to cooperate with the Societies in the financing of the work by contributions made within thirty days after placement, on the basis of one and one-half per cent of the first year's salary: temporary positions (of one month or less) three per cent of total salary received. The income contributed by the members, together with the finances appropriated by the four societies named above will it is hoped, be sufficient not only to maintain, but to increase and extend the service.

REPLIES TO ANNOUNCEMENTS.—Replies to announcements published herein or in the Bulletin, should be addressed to the key number indicated in each case, with a two cent stamp attached for reforwarding, and forwarded to the Employment Service as above. Replies received by the bureau after the positions to which they refer have been filled will not be forwarded.

POSITIONS OPEN

ENGINEER, who is familiar with the design of watthour meters and current and voltage transformers. Apply by letter stating qualifications fully and salary expected. Location, Canada. X-7740-C.

ELECTRICAL ENGINEER, graduate of 1926 or earlier. Design experience in the audio frequency end of radio sets preferred. Apply by letter, giving age, training, experience and salary expected. Opportunity for advancement in sales engineering capacity. Location, Middle west. X-7800-C.

ASSISTANT ENGINEER, of electrical distribution to make studies and plans for future expansion of distribution system, both underground and overhead 4000-volt and 12,000-volt, for a large city. Must have had similar experience with power and light company in a city of at least

500,000 population. Apply by letter giving full details in first letter, including references, samples of work, salary expected, age and recent photograph. Traveling expenses paid for conference. Location, Canada. X-7850.

MEN AVAILABLE

ELECTRICAL ENGINEER, 36, single, B. S. in E. E.; seven years of public utility experience in laboratory and field testing of power and industrial equipment, protective relays and meters. Considerable oscillographic experience. Desires position with engineering or industrial concern. No preference as to location. C-5713.

RESEARCH ENGINEER, 32, M. I. T. graduate, M. S. in E. E. Six years' experience with power companies on important test and investigation work; five years in the research department of prominent manufacturer on research and development work. B-1041.

GRADUATE ELECTRICAL ENGINEER, 25, married, desires position with development, public utility or industry. Six years of practical experience in construction and maintenance; three years coal mine superintendent. Seeks change from present position for one with greater opportunities. Location, immaterial. Working knowledge of Spanish and French. C-5746.

ELECTRICAL ENGINEER, 33, married, degree E. E., Dordrecht, Holland, desires position as construction engineer with prospects of foreign service now or later. Seven years' experience, installation, testing, automatic telephone inspector, central office, emergency repairing, drafting, supervisory control. Speaks English, Dutch, French, German. Available for any location. Now employed. C-5733.

ELECTRICAL SALES AND CONSTRUCTION ENGINEER, 31, desires connection with reliable company; graduate of two technical colleges with ten years' varied experience; seven and one-half years with largest electrical manufacturer, graduate student electrical engineers test course, experience in turbine engineering, switchboard; district office and resident agent sales; also, specialty merchandizing. C-5618.

DESIGNING ENGINEER, 37, single. Electrical engineering graduate desires position as designing engineer; thirteen years' experience in the electrical industry, seven of which were spent with public utilities, designing power plants and handling material, estimating, specifications and valuation. Now employed. Location, immaterial. C-983.

TECHNICAL GRADUATE, University of Kentucky. Five years' experience power plant and substation layout and construction; Westinghouse Test. At present, instructor of engineering in large midwestern university. Desires either summer or permanent connection. C-5734.

RECENT GRADUATE, with degree of B. S. in E. E., 27, single. Attended radio school in Pennsylvania and will graduate from Ohio University. Has worked for power company in Pennsylvania, doing drafting work in connection with extension lines. Desirous of electrical work with a company where there are possibilities of advancement. Location, immaterial. Available June 15, 1929. C-5728.

METER AND INSTRUMENT SPECIALIST, 28, single, high school and evening technical school education; five years' experience in the design, manufacture and test of meters and instruments. Available, one month. Location, immaterial. C-5771.

NEBRASKA GRADUATE, 26, single. Five years' telephone experience, including manufacturing and operating; some sales experience. Desires connection which offers sales opportunity with a future within the corporation. Location, immaterial. Available to travel on short notice. C-5770.

GRADUATE ELECTRICAL ENGINEER, of wide experience in design of large power stations, steam and hydroelectric, high-tension indoor and outdoor substations and industrial plants. Has had executive and construction experience. Capable of responsible work. Has had some manufacturing, business and sales experience. Now employed. Location preferred, East or Southeast. B-9222.

ELECTRICAL ENGINEER, 32, married, 1924 graduate. Five years' experience as distribution engineer with one of the largest utility companies in the middle west; desires a position of responsibility with a utility or manufacturing company in the West or Southwest. C-5714.

ELECTRICAL ENGINEER, 1927 graduate, B. of E. E., 24, single. Two years' practical experience in electrical and gas substation construction and the handling of men in this work. Desires connection with industrial, construction company, or public utility. C-5782.

ELECTRICAL ENGINEER, 26, single, graduate, B. S. in E. E.; two years' of mechanical and electrical testing of power plant equipment in large public utility. Desires connection with public utility or industrial concern in Middlewest. Best references. C-5776.

ELECTRICAL AND MECHANICAL ENGINEER, sixteen years' experience, married, 32; desires position as superintendent of construction or maintenance engineer; four years general and electrical superintendent in large electrochemical plant. Location in South America or Canada, available at once. C-3671.

INDUSTRIAL ELECTRICAL ENGINEER; experience in application, construction and maintenance of electrical equipment in metal working industries. Desires position as plant engineer or manufacturer's representative. B-8918.

ELECTRICAL ENGINEER, desires permanent connection in any branch of electrical work in Philadelphia District. Age 34, experienced in consulting, design, construction and test of power houses, industrial plants, substations and lighting installations. C-2570.

RESEARCH PHYSICIST, Ph. D. Nationally known for remarkable record of electrical and radio inventions. Past positions: University Professor (head of Physics Department), and Director of Theoretical Research at prominent industrial research laboratory. Present salary $12,000 per annum. C-2048.

ELECTRICAL ENGINEER, B. S., 27, recent graduate; thorough knowledge of Spanish; working knowledge of Portugese; desires connection with concern doing business in South America. Location, immaterial. C-5811.

ELECTRICAL ENGINEER, graduate, married, willing to travel. Has had two years' experience on General Electric Test, one year's sales and contract service experience, three years in the electrical contracting business and one year on valuation and appraisal work. Desires to enter sales, inspection or installation work. Available on short notice. B-9090.

ASSISTANT PROFESSOR, E. E., now in utility work and with a background of ten years, experience in classroom, supplemented by practical experience during summers, desires return to college work, in South or West. Connections have been with first class organizations. Available on one month's notice. C-1599.

MECHANICAL-ELECTRICAL ENGINEER, with twenty years' experience in the design, construction and operation of manufacturing plants and their equipment; specialty is the operation and maintenance of large manufacturing plants. Training was obtained in plants employing over 5000 men. C-5088.

POWER AND MAINTENANCE ENGINEER, technical graduate; 15 years' experience in power plant and industrial power investigation layout and operation; departmental distribution of power, steam and costs. Thorough acquaintance with steam and electrical equipment. Desires position with industrial organization. Executive and business ability. Location near Philadelphia or New York preferred. B-7492.

SALES ENGINEER, American, 39, six years as sales engineer covering United States and Canada. Nine years present position, business executive spending most of time in foreign lands. Married, steady, good health, enjoy work. Personality that wears. Thorough sales and business training. Handles French correctly. Seeks sales engineering or export connection with reliable company. Location, immaterial. Now on Pacific Coast. C-5817.

ELECTRICAL ENGINEER desires position doing research or development work. Thoroughly trained and competent meter engineer. Experienced in combustion and general laboratory and power plant testing. Has been successful along development lines; also extensive public utility experience. C-5258.

ELECTRICAL ENGINEERING GRADUATE, 31, married, desires position with manufacturing concern, public utility or contractor. Has had nine years' experience with public utility, in power factor correction, trouble investigation, supervising customers' equipment and isolated power plant tests. Located in eastern Pennsylvania at present but will consider position elsewhere. B-6546.

GRADUATE ELECTRICAL ENGINEER-EXECUTIVE, now employed, 33, married; ten years' experience, design, supervision of construction, generating sub and railway converter stations; invites correspondence from public utilities where there is an opportunity for advancement. B-6600.

ELECTRICAL-MECHANICAL ENGINEER, 31, with over six years' experience as Testing Engineer, Electrical Designer of a-c. and d-c. substations and transmission line engineer; very familiar with design of a-c. calculating boards and oscillograph, klydonograph and cathode-ray oscillograph investigations; able to analyze statistical engineering data; desires engineering position with manufacturing or public utility company. C-200.

SALES ENGINEER, desires position in district office of manufacturer of electrical equipment or as estimator in office of consulting engineer. University graduate in E. E., 39, married. At present employed in electrical engineer's office of coal mining company. Middle Atlantic States preferred. C-5835.

ENGINEER, with broad experience, both electrical and mechanical, in manufacturing desires position as chief engineer of a concern manufacturing electrical household appliances. Available on reasonable notice. A-4660.

ELECTRICAL ENGINEER, 36, married, with degrees in Science and Electrical Engineering; thoroughly experienced in the design and manufacture of electric sets, power supplies, power transformers, paper condensers; six years' experience in above products. At present employed as chief engineer, paper condensers, desires change. C-3277.

ELECTRICAL ENGINEER with twenty years' experience in making surveys, designs and supervising the construction of underground distribution systems. Has been exceptionally successful on recent three-phase four-wire systems. Individual surveys and designs considered on a monthly salary basis. Highest references from leading engineers. B-4272.

MEMBERSHIP—Applications, Elections, Transfers, Etc.

APPLICATIONS FOR TRANSFER

The Board of Examiners, at its meeting of April 3, 1929, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the National Secretary.

To Grade of Fellow

HALLBORG, HENRY E., Communications Engineer, Radio Corp. of America, New York, N. Y.

MARSHALL, ALFRED C., Vice-President and General Manager, The Detroit Edison Co., Detroit, Michigan.

To Grade of Member

BALDWIN, HOWARD D., Manager, Westinghouse Elec. & Mfg. Co., Wilkes Barre, Pa.

BAUMER, HARRY W., Acting Asst. Elec. Engr., Dept. of Gas & Electricity, Chicago, Ill.

BENNETT, JOHN W., Distribution Engineer, Eastern New Jersey Power Co., Asbury Park, N. J.

BOLICK, CLARENCE P., Operating Supervisor, Duquesne Light Co., Pittsburgh, Pa.

BROWN, ROBERT C., JR., Plant Electrician, Public Lighting Commission, Detroit, Mich.

CLARK, J. HUNTER, Executive Asst. to Chief Elec. Engr. and Gen. Mgr., Bureau of Power & Light, Los Angeles, Calif.

CURTIS, LEO H., Foreman, General Electric Co., Erie, Pa.

CURTIS, LOUIS B., Supervisor of Substations, Pennsylvania Railroad, Philadelphia, Pa.

DANIELS, HENRY, Cost Engineer, Central Hudson Gas & Elec. Corp., Poughkeepsie, N. Y.

DARLAND, ALVIN F., Supt. Elec. Construction and Design, Public Utilities Dept., Tacoma, Wash.

DIAMOND, HARRY, Radio Engineer, Bureau of Standards, Washington, D. C.

DUNBAR, JOHN ROBERT, Electrical Engineer, Canadian Westinghouse Co., Hamilton, Ont., Can.

FERGUSON, JOHN G., Telephone Engineer, Bell Telephone Labs., New York, N. Y.

FROST, GEORGE, Power Sales Engineer, Lawrence Gas & Elec. Co., Lawrence, Mass.

GARVIN, JOHN P., Central Station Layout Engineer, W. S. Bartstow & Co., Reading, Pa.

GRAHAM, VIRGIL M., Radio Engineer, Stromberg-Carlson Telephone Mfg. Co., Rochester, N. Y.

GRIFFITH, R. T., Asst. Engr. of Transmission, Bell Telephone Co. of Pa., Pittsburgh, Pa.

HOGE, CARL H., Construction Supt., Puget Sound Pr. & Lt. Co., Seattle, Wash.

KAYLER, KENNETH W., Operating Engineer, Duquesne Light Co., Pittsburgh, Pa.

KELLY, JAMES F., Electrical Plant Engr., Public Service Elec. & Gas Co., Newark, N. J.

KIRKPATRICK, CHARLES M., Asst. Northeastern Central Station Mgr., Westinghouse Elec. & Mfg. Co., New York, N. Y.

LARSON, LUDVIG C., Instructor of Elec. Engg., University of Wisconsin, Madison, Wis.

LUMLEY, CHARLES S., Electrical Engineer, Smith, Hinchman & Grylls, Detroit, Michigan.

LUTHER, GEORGE D., Manager—Seattle Branch—Electric Storage Battery Co., Seattle, Wash.

MACGREGOR, JOHN R., Chief Engr., Bell Tel. Co. of Pa., Pittsburgh, Pa.

MATHES, ROBERT C., Communication Engineer, Bell Telephone Labs., New York, N. Y.

MESS, CHARLES T., Asst. Engr., California Railroad Commission, San Francisco, Calif.

MOON, PARRY H., Instructor, Mass. Inst. of Tech., Cambridge, Mass.

PAQUE, E. J., General Works Engineer, The Pollak Steel Co., Cincinnati, Ohio.

RITTER, RALPH W., Engineer, Electric Storage Battery Co., Philadelphia, Pa.

ROST, HELGE, Chief Electrical Engineer, Empresa de Telefonos Ericsson, S. A., Mexico, D. F. Mex.

SHANKLIN, GEORGE B., Elec. Engr., General Elec. Co., Schenectady, N. Y.

SILENT, HAROLD C., Elec. Engr., Electrical Research Products, Inc., Los Angeles, Calif.

STANNARD, JAY L., Chief Engineer, Cushman Power Project, Tacoma, Wash.

TEACH, FRANK A., Asst. Elec. Engr., Gusta Hirsch Organization, Columbus, Ohio.

TOWNSEND, WISNER R., Engineer, Baker & Spencer, Inc., New York, N. Y.

WALTON, PERCY J., Elec. Engr., General Elec. Co., Philadelphia, Pa.

WILLIAMS, HAROLD W., Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

WOODWORTH, LEON B., Sectional Engineer, Central Mining & Investment Corp., Johannesburg, Transvaal, So. Africa.

YANG, SIH-ZUNG, Sales Manager, Elbrook Inc., Shanghai, China.

APPLICATIONS FOR ELECTION

Applications have been received by the Secretary from the following candidates for election to membership in the Institute. Unless otherwise indicated, the applicant has applied for admission as an Associate. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the Secretary before May 31, 1929.

Adrian, M. J., Westinghouse Elec. & Mfg. Co., New York, N. Y.

Bartol, L. W., Westchester Lighting Co., Mt. Vernon, N. Y.

Bates, R. P., General Electric Supply Corp., Houston, Tex.

Baumgartner, R. P., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Baxter, F. H., Shawinigan Water & Power Co., Shawinigan Falls, Que., Can.

Berg, E. E., (Member), Pacific Power & Light Co., The Dalles, Ore.

Berry, R. U., General Electric Co., Schenectady, N. Y.

Bickford, C. L., Electrical Contracting, New Hampton, N. H.

Buchholz, W. F., Midwest Refining Co., Midwest, Wyo.

Buck, F. G., Pennsylvania Water & Power Co., Baltimore, Md.

Budden, D. V., (Member), Benjamin Electric Mfg. Co., New York, N. Y.

Butler, L. W., Wisconsin Telephone Co., Milwaukee, Wis.

Cain, J. T., Louisiana Power & Light Co., Sterlington, La.

Calverley, W. R., Railway & Industrial Engineering Co., Pittsburgh, Pa.

Carpenter, E. R., Iowa Southern Utilities Co., Centerville, Iowa

Carroll, W. L., Westinghouse Electrical International Co., New York, N. Y.

Carter, G. B. L., (Member), Southwestern Bell Tel. Co., Oklahoma City, Okla.

Chen, D. S., Globe Electric Co., Milwaukee, Wis.

Clark, L. B., P. O. Box 97, Parker, Indiana

Coe, E. R. C., International Communication Labs., Inc., New York, N. Y.

Cooney, R. T., Jr., J. G. White Engineering Corp., Boling, Tex.

Cooper, L. S., Philadelphia Rural Transit Co., Philadelphia, Pa.

Criss, F. W., Mississippi Power & Light Co., Lexington, Miss.

Cunning, J. C., Bureau of Power & Light, Los Angeles, Calif.

Dillon, H. A., Jr., Dillon Electric Service Station, Gloversville, N. Y.

Dinwiddie, E. H., Southwestern Bell Telephone Co., Oklahoma City, Okla.

Doherty, H., Steam Yacht "Viking," New York, N. Y.

Earnheart, R. L., General Electric Co., Erie, Pa.

Edwards, J. H., Jr., Kansas City Power & Light Co., Kansas City, Mo.

Ely, H. D., Kansas City Power & Light Co., Kansas City, Mo.

Emme, M. T., Western Electric Co., Minneapolis, Minn.

Evans, A. E., (Member), Commonwealth Edison Co., Chicago, Ill.

Evans, S., (Member), Hughes Tool Co., Houston, Tex.

Foster, J. A., Standard Public Service Co., Columbus, Ohio

Fredericks, P. G., (Member), Jeffery DeWitt Insulator Co., New York, N. Y.

Frendenthal, J., Brunswick, Balke, New York, N. Y.

Fuller, R. A., General Electric Co., Philadelphia, Pa.

Gebhardt, P. B., Colin B. Kennedy Corp., South Bend, Ind.

Gordon, M. K., Jr., Brandes Products Corp., Newark, N. J.

Groeneveld-Meijer, N. E., (Member), Allgemeine Elektricitats Gesellschaft, Schenectady, N. Y.

Hays, H. M., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Heinrich, J., Kansas City Power & Light Co., Kansas City, Mo.

Hopkins, P. E., Public Service Co. of No. Illinois, Chicago, Ill.

Howard, F. M., Mountain States Power Co., Casper, Wyo.

Ingersoll, H., United Illuminating Co., New Haven, Conn.

Jagou, C. C., Westinghouse Electric International Co., New York, N. Y.

James, H. C., Henningson Engg. Co., Omaha, Nebr.

Jurss, G. W., Val. Blatz Brewing Co., Milwaukee, Wis.

Kane, E. K., General Electric Co., Pittsfield, Mass.

Kenneally, M. M., (Member), Ohio Brass Co., New York, N. Y.

Knauer, G. W., Northwestern Bell Telephone Co., Fargo, No. Dak.

Knowles, H. F., Edison Electric Illuminating Co. of Boston, Dorchester, Mass.

Knox, J. A., Bell Telephone Co. of Pa., Pittsburgh, Pa.

Lamperti, L., United Electric Light & Power Co., New York, N. Y.

Larsen, L. P., Ford Motor Co., St. Paul, Minn.

Levy, M. W., Kansas City Power & Light Co., Kansas City, Mo.

Lewis, M. T., Southwestern Bell Tel. Co., Dallas, Tex.

Lyons, S. H., Southwestern Bell Telephone Co., Oklahoma City, Okla.

Malone, J. F., Claude Neon Lights, Inc., Long Island City, N. Y.

Marrs, R. E., General Electric Co., Schenectady, N. Y.

Mathewson, P. L., Canadian Westinghouse Co., Hamilton, Ont., Can.

McDonald, R., 2 Ord St., San Francisco, Calif.

McKinnes, J., Watson-Flagg Engineering Co., Paterson, N. J.

Meurer, E. E., Bell Telephone Co. of Penna., Pittsburgh, Pa.
Moody, F. B., Westinghouse Elec. & Mfg. Co., Sharon, Pa.
Moorhouse, C. E., Canadian Westinghouse Co., Ltd., Hamilton, Ont., Can.
Morf, E. B., Latourrette Fical Co., San Francisco, Calif.
Morris, W. G., Home Tel. & Tel. Co., Spokane, Wash.
Mumm, A., Leeds & Northrup Co., Philadelphia, Pa.
Murr. A., Interborough Rapid Transit Co., New York, N. Y.
O'Connor, F. P., Interborough Rapid Transit Co., New York, N. Y.
Pace, G. L., Ingenio Santa Fe C. por A. San Pedro de Macoris, Dominican Republic
Palmer, O. H., Mississippi Power & Light Co., Lexington, Miss.
Parlas, J. L., 103 East Madison Ave., Niles, Ohio
Paxton, E. T., General Electric Supply Corp., Dallas, Tex.
Pettibone, G. W., American Tel. & Tel. Co., New York, N. Y.
Phillips, F. L., Kansas City Power & Light Co., Kansas City, Mo.
Pohl, A., (Member), Westinghouse Elec. & Mfg. Co., Newark, N. J.
Rathbun, H. V., Kansas City Power & Light Co., Kansas City, Mo.
Reis, J. F., Westinghouse Elec. & Mfg. Co., Sharon, Pa.
Richardson, G. B., Texas Power & Light Co., Dallas, Tex.
Rindlaub, W. W., Philadelphia Electric Co., Philadelphia, Pa.
Russell, C. E., Russell's Radio Service, Coffeyville, Kans.
Schuler, K. E., Central West Public Service Co., Omaha, Nebr.
Scribante, P. P., Star-Delta Electric Works, San Francisco, Calif.
Shinkevich, E. A., International General Electric Co., Schenectady, N. Y.
Shore, H., United Electric Light & Power Co., New York, N. Y.
Skinner, C. H., (Member), Marquette University, Milwaukee, Wis.
Smith, C. J., Jr., Chesapeake & Potomac Tel. Co., Baltimore, Md.
Smith, J. S., (Member), Marconi International Marine Comm. Co., Ltd., New York, N. Y.
Stark, R. G., Erie Malleable Iron Co., Erie, Pa.
Summer, M. D., (Member), Westinghouse Elec. & Mfg. Co., Buffalo, N. Y.
Swoish, W. R., Westinghouse Elec. & Mfg. Co., Buffalo, N. Y.
Test, L. J., Atlantic Refining Co., Philadelphia,, Pa.
Thwaite, W. E., Jr., New York Edison Co., New York, N. Y.
Treat, V. A., Pacific Electric Mfg. Corp., San Francisco, Calif.
Turner, A. L., (Member), Northwestern Bell Tel. Co., Omaha, Nebr.
Turner, J. G., United Engineers & Constructors, Inc., Philadelphia, Pa.
Vellines, W. E., Jr., West Virginia University, Morgantown, W. Va.
Waite, G. G., Sangamo Electric Co. of Can. Ltd., Toronto, Ont., Can.
Warner, J. L., Chesapeake & Potomac Telephone Co., Baltimore, Md.
While, E. M., New York Edison Co., New York, N. Y.
Whitaker, D. W., West Texas Utilities Co., Abilene, Tex.
Williams, V. C., Jr., W. S. Barstow & Co., Inc., Reading, Pa.
Total 104.

Foreign

Bard, A. G. T., Chile Exploration Co., Chuquicamata, Chile, So. America
Bogra, A. C., No. 8 Mozang Road, Lahore, Punjab, India
Davidson, J. M., J. M. Davidson & Co., Salisbury, Rhodesia, Africa
Fellows, H. S., Melbourne Electric Supply Co., Ltd., Melbourne, Australia
Kaul, R. K., Kashmir Hydro-Electric Installation, Baramulla, Kashmir, India
Mera, J. R., Porto Rico Irrigation Service, Villalba, Porto Rico
Perevozsky, N. F., (Member), Kharkov Works; Kharkov Institute of Technologie, Kharkov, U. S. S. R.
Sampaio, L. F., Companhia Paulista de E. F., Jundiahy, Sao Paulo, Brazil, So. America
Spary, P. G., (Member), University College, Southampton, Eng.
Subramanian, P., Water Works Division, Coimbatore, Deccan, India
Tandon, C. P. L., Lahore Electric Supply Co., Lahore, Punjab, India
Upadhia, J. P., East Indian Railway, Cawnport Junction, U. P., India
Total 12.

STUDENTS ENROLLED

Anderson, Laurence, University of California
Bailey, Carl, Iowa State College
Bailey, Frederick N., University of Wisconsin
Barnes, George W., University of Nevada
Beizer, Harold, University of Pennsylvania
Bennett, George R., Jr., University of Alabama
Bennett, William J., University of Alabama
Berggren, Willard P., University of California
Betts, R. Leland, University of Wisconsin
Biggi, John F. A., Rensselaer Polytechnic Institute
Bodner, Jack, University of Virginia
Borden, Elmer R., Lewis Institute
Born, Maynard R., Stanford University
Bornemann, Walter E., Cornell University
Branch, J. O., Virginia Polytechnic Institute
Brown, Rodney J., University of California
Burns, John L., Northeastern University
Campbell, Charles J., University of Wisconsin
Ciccolella, David F., Rensselaer Polytechnic Inst.
Clark, Gordon L., Tufts College
Clark, Paul, University of Alabama
Clausen, Arnold H., University of California
Clement, Percival E., University of Alabama
Cobb, Edgar E., Oklahoma A. & M. College
Cobb, Willie O., Oklahoma Agricultural & Mechanical College
Codling, Eldred P., University of Cincinnati
Crowell, Donald C., University of California
Daniels, George A., University of California
Davis, Thomas, University of Virginia
DeLange, Owen E., University of Utah
Dennis, Walter J., Jr., Stanford University
Dent, Roy F., Jr., University of Kansas
Denton, Sidney M., University of Alabama
Doberer, Cameron, McGill University
Dohr, Edmund N., Marquette University
Dugar, Alvin N., Northeastern University
Edson, Thomas F., California Institute of Tech.
Elder, Thomas A., Ohio University
Ellison, James R., Oklahoma A. & M. College
Englund, Ray V., University of Minnesota
Esberg, Alfred M., Stanford University
Evans, Opie D., Oklahoma A. & M. College
Fairweather, Robert W., University of Wisconsin
Farris, Orrin F., University of California
Federici, Maurizio E., Harvard University
Flechsig, Alfred J., State College of Washington
Fogg, William C., University of Cincinnati
Fry, Richard E., University of California
Gable, William G., University of Alabama
Galperin, Boris M., Drexel Institute
Gerow, Clarence H., Jr., Rensselaer Polytechnic Institute
Gibson, Hal, Oklahoma A. & M. College
Gioberti, Peter A., College of the City of New York
Griffin, Jack P., Colorado State Agri. College
Gurney, Edward W., University of California
Hammar, Sam J., State College of Washington
Hanson, Robert C., University of Alabama
Hassell, Owen C., University of Alabama
Hattox, James G., Mississippi Agricultural & Mechanical College
Hayes, James F., University of California
Heald, Sherman T., University of Cincinnati
Heikkila, Frank E., Montana State College
Hierath, Doran C., State College of Washington
Hill, Shelby W., Oklahoma A. & M. College
Hill, Vernon C., University of Alabama
Hoadley, George B., Swarthmore College
Hoffman, William H., Jr., University of Illinois
Honeychurch, Frank, University of California
Hughes, Arthur J. Jr., Duke University
Hulsey, Mardis O., University of Alabama
Johnson, John E., Lehigh University
Keyes, Kenneth A., University of California
Kutcher, William J., University of Cincinnati
Leissring, Elton H., Marquette University
Lewis, Lawrence, Kansas State Agri. College
Lindell, Carl H., University of Cincinnati
Lindsay, Seaton G., Jr., Duke University
Macaulay, William R., Rensselaer Polytechnic Institute
Marks, Louie W., Johns Hopkins University
Martin, Peter E., University of Alabama
Mathison, Theodore, State College of Washington
Mattheisz, William H., Johns Hopkins University
McGahan, John D., Ohio Northern University
McLeod, William J., University of California
McMahan, Kenton D., Oklahoma A. & M. College
Merchant, William J., Johns Hopkins University
Merkel, Clifford L., University of California
Meyer, Ernst B., University of Cincinnati
Meyer, Fred J., Marquette University
Miller, Charles J., University of California
Miracle, Wilfred R., Engineering School of Milwaukee
Mitchell, Gordon S., California Institute of Tech.
Moore, James S., Jr., University of Pennsylvania
Morton, Allan B., Jr., Georgia School of Tech.
Morton, George V., Jr., Brooklyn Polytechnic Inst.
Moser, Robert C., Ohio State University
Neal, James P., University of Cincinnati
Newberry, Thomas W., Georgia School of Tech.
Nystrom, Roland L., University of California
Oberwise, Matthew L., Marquette University
Ochs, Allan, University of California
Oppenheimer, Max L., University of Texas
Overton, John W., Jr., Virginia Polytechnic Inst.
Palmrose, Edwin W., University of California
Patorno, George, College of the City of New York
Polley, Terence A., University of California
Redman, F. Munro, Stanford University
Remsen, C. Cornell, Jr., Cornell University
Robertson, Samuel B., Duke University
Robbins, Len G., Montana State College
Roswell, Kenneth E., Rensselaer Polytechnic Inst.
Rutemiller, Oren G., University of Cincinnati
Salo, Eric A., New York University
Scales, Charles R., University of Texas.
Scott, Harold W., Northeastern University
Seielstad, Harold D., University of Wisconsin
Shaver, Karl, Kansas State Agricultural College
Sherard, Henry M., Jr., Duke University
Shrader, William O., University of Alabama
Simpson, Harrison B., Cornell University
Singewald, M. Louis, Johns Hopkins University
Stanley, Harry C., University of California
Steinbrenner, George R., Northeastern University
Stewart, Welby E., University of Nebraska
Suter, Henry, University of Cincinnati
Swanson, Swen C., Montana State College
Tabor, Herbert S., Georgia School of Technology
Thomson, Walter A., University of Toronto
Truesdell, Ralph E., North Carolina State College
Vance, Arthur W., Kansas State Agri. College
Vance, Paul E., University of Tennessee
Voorhees, Henry A., University of Illinois
Walker, James A., University of Alabama
Walton, Edward M., University of Alabama
Weir, John O., Engineering School of Milwaukee
White, Ira M., University of California
Wilson, H. Warden, University of Pennsylvania
Windust, George, State College of Washington
Winschuh, John H., Rensselaer Polytechnic Inst.
Wood, Richard M., George Washington, Univ.
Young, Charles C., University of Alabama
Zilberman, Mendel C., Carnegie Institute of Tech.
Ackley, Eli H., University of Texas
Total 143.

OFFICERS A. I. E. E. 1928-1929

President
R. F. SCHUCHARDT

Junior Past Presidents
C. C. CHESNEY — BANCROFT GHERARDI

Vice-Presidents
O. J. FERGUSON — E. B. MERRIAM
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J. L. BEAVER — W. T. RYAN
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NEW CATALOGUES AND OTHER PUBLICATIONS

Mailed to interested readers by issuing companies

Transformers.—Bulletin 1724-A, 16 pp., Modern Power Transformers.—Describes the manufacture, testing and auxiliaries of Westinghouse power transformers. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Oil Switches.—Bulletin AE-600. Describes a new line of Roller-Smith oil switches and circuit breakers and marking the entry of the company into this field. Roller-Smith Company, Smith Company, 12 Park Place, New York.

Electrically Operated Valves.—Bulletin 100, 4 pp. Describes electrically operated valves of the solenoid magnet type to control the flow of oil, water, gas, air, etc. Electric Valve Mfg. Co., 68 Murray Street, New York.

Lightning Arresters.—Bulletin GEA-93D, 8 pp. Describes G-E line-type lightning arresters, pellet oxide film, for application to a-c. circuits of voltages up to 50,000, for outdoor service only. General Electric Company, Schenectady, N. Y.

Bus and Cable Connectors.—Bulletin, 4 pp. Describes the application of Burndy connectors used for round and flat conductors in the Pennsylvania Railroad substation at Lamokin. This is part of the program for electrifying the main line of the Pennsylvania Railroad from New York to Wilmington. Burndy Engineering Co., Inc., 10 East 43rd St., New York.

Metal-Clad Switchgear.—Bulletin GEA-966A, 6 pp. Describes type MI-1 metal clad switchgear for indoor service, 400 to 3000 amperes at 7500 volts; 400 to 1600 amperes at 15,000 volts. General Electric Company, Schenectady, N. Y.

Motor and Factory Maintenance Equipment.—Catalog 12, 36 pp. Describes a line of commutator stones, grinding and turning tools, undercutters, paint sprayers, insulation meters, circuit testers, etc. The Martindale Electric Company, 1260 West 4th Street, Cincinnati, O.

Portable Power Units.—Bulletin 14-1000, 4 pp. Describes Century portable power units for farm applications, built in standard 3, 5 and 7½ horsepower sizes. Farm machines that are successfully operated by these units are listed. Century Electric Company, 1806 Pine Street, St. Louis, Mo.

Radio Continuity Tester.—Leaflet, supplement to Bulletin 300. Describes a new type of HTD radio continuity tester for making continuity and resistance tests on radio receiving and transmitting sets and on other radio devices and circuits. Roller-Smith Company, 12 Park Place, New York.

Electrical Fire Prevention. Bulletin, 16 pp., entitled "Killing Electrical Fires" and describing "Alfite," a system for extinguishing fires by carbon dioxide gas. The use of the new Westinghouse light relay, claimed to be the fastest known method for detecting fire and automatically actuating the "Alfite" system, is also outlined. American LaFrance & Foamite Corporation, Utica, N. Y.

Transformer Oil.—Bulletin 162, 8 pp. Describes Wagner transformer oil specifications originally prepared for their own organization only, but recently released for transformer buyers and users. Discusses the purposes of transformer oil, its properties, methods of testing, precautions when handling and storing. Wagner Electric Corporation, 6400 Plymouth Street, St. Louis, Mo.

Diverter Pole Generator.—Bulletin 94, 12 pp. Describes the use of the diverter pole generator for floating with bus control batteries. The advantages of the machine over a shunt-wound generator are outlined, and longer battery life is claimed for the diverter pole generator by reason of its maintaining automatically the correct charging rate. Rochester Electric Products Corp., 87 Allen Street, Rochester, N. Y.

NOTES OF THE INDUSTRY

The Kuhlman Electric Company, Bay City, Michigan, manufacturers of power, distribution and street lighting transformers, announces the appointment of S. L. Currier, 833 Union Trust Building, as representative in the Cincinnati territory.

Brown Instrument Company Enlarges Plant.—Due to the rapid growth of its business, new building of reinforced concrete, which will cost approximately $200,000, have been started by the Brown Instrument Company, Philadelphia .The floor space of the present plant will be increased 50% when the new construction is completed.

General Electric Reports Increased Business.—Orders received by the General Electric Company for the first quarter of 1929 amounted to $101,365,208, compared with $79,925,840 for the corresponding three months of last year, an increase of 27 per cent.

Delta-Star Expands.—Announcement has been made by H. W. Young, president of the Delta-Star Electric Company, Chicago, that the following additions to the manufacturing and distribution facilities have been effected.

The Champion Switch Company has been purchased and the Kenova, West Virginia plant will continue manufacturing its present line of equipment in addition to several new designs.

Manufacturing arrangements have been completed with the Societe D'Installations et de Constructions Electriques et Mecaniques, Boulogne-sur-Seine, to manufacture and distribute Delta-Star equipment in France and its colonies.

An interest has also been acquired in the Monarch Electric Limited, St. Johns, Quebec, which will soon be operated as the Monarch Delta-Star Company. At the Canadian factory will be manufactured a complete line of Delta-Star equipment—in addition to the present switching equipment, switchboards, oil circuit breakers and oil switches. New designs of large capacity oil breakers for voltages up to 132 kv. will be added shortly.

Delta-Star equipment will be handled by its established sales organization and the Kenova Champion works will be operated as a separate unit with its own sales organization. The St. Johns factory will handle all business for Canada and the British possessions and the French factory will have its own sales organization. Under the new arrangement domestic and foreign requirements can be met with an extensive line of air and oil break switching or substation equipment.

General Cable Corporation Appointed Agent for Copperweld.—The General Cable Corporation announces the consummation of an agency agreement with Copperweld Steel Company whereby General Cable Corporation is appointed the sole and exclusive agent in the United States to draw wire from Copperweld rods and to sell wire so drawn and wire products made therefrom.

Copperweld Steel Company has recently enlarged its special equipment for the production of Copperweld billets and rods and General Cable Corporation has, in its several plants, large capacity for the drawing of these rods into wire and for the fabrication of wire products. These complementary facilities, together with the engineering, sales and distribution organizations of both companies, will be effective to secure increased production and distribution of Copperweld wire and wire products, together with improved service to all users of Copperweld material.

Hereafter all copper covered steel wire and wire products handled by General Cable Corporation will be produced exclusively from Copperweld material. Full and complete sales and engineering service on Copperweld wire and wire products is now available through each of the Divisions of General Cable Corporation.